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BIRDS IN RELATION TO THE ALFALFA WEEVIL.

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INTRODUCTION.

The alfalfa weevil (*Phytonomus posticus* Gyll.), a pest introduced into the United States, has for several years been doing enormous damage to alfalfa crops in Utah. On invitation of and in cooperation with the Bureau of Entomology, the Biological Survey therefore undertook to ascertain the part played by birds and mammals in checking the increase of the weevil. Accordingly the writer spent from May 8 to July 25, 1911, and from April 1 to August 15, 1912, at various points in the infested region, investigating the food habits of local birds and of a few batrachians and other vertebrates. This bulletin chiefly considers the food habits of birds, but facts concerning the economic status of other vertebrates also are included.

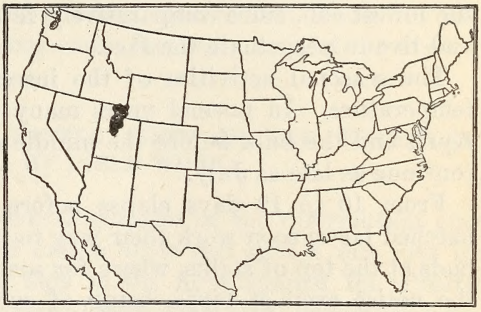

Fig. 1.—Known distribution of the alfalfa weevil (*Phytonomus posticus*), May 1, 1914. (Map by Bureau of Entomology.)

IMPORTATION AND SPREAD OF THE ALFALFA WEEVIL IN UTAH.

The time and method of initial introduction of the alfalfa weevil into Utah is unknown, but the first serious damage was noted in the spring of 1904, when a small infestation a few miles southeast of Salt Lake City was discovered. From this foothold the weevil spread and by September, 1911, had extended as far north as Tremonton,

Note.—This bulletin discusses the food habits and economic status of birds, and of the toad, frog, and a few other vertebrate enemies of the alfalfa weevil in Utah.

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Utah, east to Evanston, Almy, and Lyman, Wyo., and northeast to Cokeville, Wyo., Randolph and Laketown, Utah, and Fish Haven, Idaho.[1]

An insect must become fairly common before it can form an appreciable portion of the food of birds; in most of the area covered by the writer's investigations the weevil probably had not become abundant until 1907 or 1908, and doubtless had not attracted the attention of birds much before that time. Thus any preference shown by birds for this character of food was necessarily acquired in the short period of four or five years.

LIFE HISTORY OF THE WEEVIL.[2]

The alfalfa weevil is a small snout beetle a little less than one-fourth inch in length, and when it appears in spring its color is very dark brown or black. It passes the winter in the adult stage, protected under piles of rubbish, in vegetation along ditch banks, the base of haystacks, etc. The beetles soon become active, and on fair, warm days may be found flying, sometimes in considerable numbers, when some fall prey to the earlier arrivals among the flycatchers and swallows. At this time of year the numbers are at the lowest ebb, since comparatively few survive the rigors of winter and live to perpetuate the race.

The seasonal activities of the insect are influenced strongly by temperature. In normal years many eggs are laid by the first of April and the bulk before the middle of June, but the process may continue as late as July.

From 10 to 12 days elapse before hatching. The pale, newly hatched larvæ soon work their way to the tender leaves and growing buds at the top of stalks, where for some time they may easily escape the notice even of birds, being of such minute size and confining their early feeding to the inner folds of the leaves. At first the larvæ restrict their depredations to the more succulent portions of the foliage, but by the time they have become full sized they feed anywhere upon the plant where green leaves remain.

The larvæ become full-grown in from 20 to 60 days, and during this time they pass through three stages. When fully developed they are about one-fourth of an inch long, of a bright green color, and have a conspicuous white stripe down the back. A paler stripe on each side and the black head aid in distinguishing it from other larvæ.

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[1] Webster, F. M., Bull. 112, Bu. of Entomology, U. S. Dept. of Agr., May, 1912.

[2] The entomological data here given are from Bull. 112 of the Bu. of Entomology, U. S. Dept. of Agr., by F. M. Webster, and Bull. 110, Utah Agr. Coll. Exp. Sta., by E. G. Titus.

In the Salt Lake Valley the bulk of the larvæ appear in May and June, but at higher altitudes somewhat later. The period of greatest abundance is at the time of the first alfalfa harvest. The insects usually make heavy inroads on the first crop and after the harvest do serious harm by retarding the growth of the second crop. All new shoots are devoured as soon as they appear, and a field frequently remains barren for three to five weeks after the first cutting.

When full-grown the larvæ cease feeding, drop to the ground, and spin rather loosely woven cocoons, which are often attached to dry vegetation at the base of the plant. The insect now passes through the pupal stage and in from one to two weeks emerges as the adult. In this stage it is covered with many fine scales or hairs which give it a light brown color. The adults begin to appear in large numbers about the first of July and may often be found clustering by hundreds upon vegetation about the borders of recently cut fields or near the bases of newly constructed haystacks. Frequently they feed upon the foliage and scar the stems of plants other than the Leguminosæ; the writer has seen healthy amaranth plants laid prostrate in a comparatively few hours.

After a short period of flight, when again some may fall prey to birds that feed on the wing, the insects seek hidden places for the winter's hibernation. Beginning soon after early August the weevils appear less in evidence.

DISTRIBUTION OF WEEVIL-EATING BIRDS IN THE TERRITORY COVERED BY FIELD WORK.

The following somewhat general synopsis of the distribution and relative abundance in Utah of native birds will give a fair idea of the species most available as aids in the fight against the alfalfa weevil. This, combined with details regarding each species, as later presented, will show which birds are doing the most good in any locality.

One of the regions most severely infested by the weevil was that immediately south and southwest of Salt Lake City, extending east and west to the edge of the irrigated land. This has an average width of 4 miles and through it flows the Jordan River. In this area the English sparrow is the most abundant bird. Next comes Brewer's blackbird and in smaller numbers are the red-winged blackbirds, which confine the bulk of their feeding to the vicinity of marshes along the river or places where lack of drainage has produced ponds. Following these are Brewer's, vesper, and lark sparrows, and meadowlarks. Robins, though very numerous in migration, are not so frequently met at a later date. The remaining common birds, named approximately in the order of their abundance,

are the rough-winged swallow, house finch, killdeer, horned lark, Arkansas kingbird, mourning dove, California quail, Bullock's oriole, black-headed grosbeak, cowbird, and yellow-headed blackbird.

A bird population differing in relative numbers from that of the region just described is found in Davis County, lying to the north of Salt Lake City and extending from the Wasatch Mountains to the Lake. As the area is narrow (at Farmington only about 4 or 5 miles wide), and is bordered on one side by the foothills and on the other by the barren flats of Great Salt Lake, a great variety of bird life may be found on a single farm. The English sparrow is not so plentiful, Brewer's blackbird being the most abundant species, but nearer the Lake the red-wings and yellow-heads vie with it for supremacy in numbers. California gulls sometimes occur in flocks of several hundred, especially where land is being cultivated. Magpies also are conspicuous and breed extensively in trees growing along creeks. The other species previously mentioned maintain about the same relative abundance, except that robins, Arkansas kingbirds, and other flycatchers are somewhat more numerous.

In the valley of the Weber the number of species is more limited, but there is no dearth of individuals. Here, as well as along Chalk Creek, which flows into the Weber, irrigated fields border the river in a long narrow strip, 1 to 2 miles wide. Bird life has segregated itself in these fields, while large numbers of birds which build in the sagebrush of the surrounding hills secure the bulk of food for themselves and their young in the lower, more fertile, tracts.

A "bench" lying to the east of this section and at some distance from the river afforded similar conditions and proved a most excellent feeding area for a number of more or less desert species dwelling on the sides of adjacent hills. Brewer's blackbirds were the most abundant, while along the upper borders of these fields and on the "bench" Brewer's, vesper, chipping, lark, and savannah sparrows appeared in great numbers. The green-tailed towhee, sage thrasher, and mountain bluebird also were present. On the lower fields robins were very numerous and bobolinks not uncommon, but no English sparrows were found.

The section about Alpine and American Fork, in Utah County, presented an avifauna very similar to that immediately south of Salt Lake City.

BIRDS FEEDING ON THE WEEVIL.

The following list includes all of the important bird enemies of the alfalfa weevil. Probably some spring migrants pick up a few while passing and some resident species, whose ordinary habits and food preferences would seem to preclude them from being enemies of the weevil, may occasionally feed on them. In the two

seasons' work 45 species of birds were found to have eaten the insect, as follows:

California gull (*Larus californicus*).
Wilson's phalarope (*Steganopus tricolor*).
Killdeer (*Oxyechus vociferus*).
Valley quail (*Lophortyx californica vallicola*).
Western mourning dove (*Zenaidura macroura marginella*).
Red-shafted flicker (*Colaptes cafer collari*
Arkansas kingbird (*Tyrannus verticalis*).
Say's phœbe (*Sayornis sayus*).
Traill's flycatcher (*Empidonax trailli trailli*).
Desert horned lark (*Otocoris alpestris leucolæma*).
Magpie (*Pica pica hudsonia*).
Long-crested jay (*Cyanocitta stelleri diademata*).
Woodhouse's jay (*Aphelocoma woodhousei*).
Bobolink (*Dolichonyx oryzivorus*).
Cowbird (*Molothrus ater ater*).
Yellow-headed blackbird (*Xanthocephalus xanthocephalus*).
Thick-billed redwing (*Agelaius phœniceus fortis*).
Western meadowlark (*Sturnella neglecta*).
Bullock's oriole (*Icterus bullocki*).
Brewer's blackbird (*Euphagus cyanocephalus*).
House finch (*Carpodacus mexicanus frontalis*).
Pine siskin (*Spinus pinus*).
Western vesper sparrow (*Poœcetes grammineus confinis*).
Western savannah sparrow (*Passerculus sandwichensis alaudinus*).
Western lark sparrow (*Chondestes grammacus strigatus*).
White-crowned sparrow (*Zonotrichia leucophrys leucophrys*).
Western chipping sparrow (*Spizella passerina arizonæ*).
Brewer's sparrow (*Spizella breweri*).
Desert song sparrow (*Melospiza melodia fallax*).
Lincoln's sparrow (*Melospiza lincolni lincolni*).
Spurred towhee (*Pipilo maculatus montanus*).
Green-tailed towhee (*Oreospiza chlorura*).
Black-headed grosbeak (*Zamelodia melanocephala*).
Lazuli bunting (*Passerina amœna*).
Cliff swallow (*Petrochelidon lunifrons lunifrons*).
Bank swallow (*Riparia riparia*).
Rough-winged swallow (*Stelgidopteryx serripennis*).
Yellow warbler (*Dendroica æstiva æstiva*).
Macgillivray's warbler (*Oporornis tolmiei*).
Long-tailed chat (*Icteria virens longicauda*).
Sage thrasher (*Oreoscoptes montanus*).
Long-tailed chickadee (*Penthestes atricapillus septentrionalis*).
Western robin (*Planesticus migratorius propinquus*).
Mountain bluebird (*Sialia currucoides*).
English sparrow (*Passer domesticus*).

CALIFORNIA GULL.

(*Larus californicus.*)

No bird in the Salt Lake Valley is held in so great esteem by the people of Utah as the California gull. On numerous occasions in

spring the writer witnessed the work of this bird on alfalfa fields, where it was common to see 200 to 300 following a harrow or plow in search of grubs, cutworms, and other insects turned up. Only five gulls were examined, and all but one were from badly infested alfalfa fields. In the stomach of only one was the weevil found.

Other prey, such as earthworms, ground beetles, and fly larvæ, seemed more attractive than the weevil to these birds. Apparently some had recently been feeding on the barren alkali flats surrounding Great Salt Lake. In one stomach were about 450 of the small carabid beetle (*Pogonus planatus*), so common about the decayed bodies of waterfowl which have died of disease in the vicinity of the Jordan River marsh, and in another were large numbers of pupæ of the alkali fly (*Ephydra gracilis*).

Though the California gull is one of the most valuable of Utah birds, as a weevil destroyer it is unimportant. However, so important are its services in other directions that it deserves the careful protection it receives.

WILSON'S PHALAROPE.

(*Steganopus tricolor.*)

A single stomach of Wilson's phalarope was examined, and the remains of one adult weevil were detected. Wilson's phalarope, however, can not be expected to render much service as a weevil destroyer, as its feeding habits restrict it largely to the immediate vicinity of lake shores and river banks.

KILLDEER.

(*Oxyechus vociferus.*)

The killdeer is found everywhere in the Salt Lake Valley, even to the upper edges of watered lands, where the highest irrigating ditches supply it with all the aquatic environment it needs. However, it appears to be more widely scattered in the spring than later in the season, when more are found about Great Salt Lake and along the Jordan River. Irrigation on an alfalfa field is always a great attraction, and in such situations as many as six or eight of these birds may be found in a field of three to four acres. Cutworms here fall easy prey.

Nineteen killdeers were examined, six of which were obtained in April. The weevil, aggregating 3.5 per cent of the food, was found in five of the six taken in that month. In each case the adult form was eaten and was found on an average of $4\frac{2}{3}$ per stomach.

Caterpillars (cutworms in some cases) constituted nearly 37 per cent of the food, and ground beetles came next with a percentage of 19.3. A large quantity of aquatic beetles in one stomach brought the monthly average of this food up to nearly 9 per cent, while

carrion beetles (Silphidæ and Staphylinidæ), click beetles, dung beetles (*Aphodius*), and weevils other than *Phytonomus* were frequent constituents of the remaining animal food. The vegetable portion was either weed seeds or rubbish.

Three of five killdeers obtained in May had fed on the weevil to the extent of over 36 per cent of the food. In one, these insects composed the entire contents, save a trace of darkling and ground beetles. It required no less than 40 adults and 1 larva of the weevil to satisfy this bird's appetite. Another had eaten 18 adults.

Of the other food taken during May, spiders, ground beetles, aquatic beetles, flies, bees, and wasps occurred in quantities decreasing in the order named. The high proportion of spiders recorded was the result of one of the birds having fed on them almost exclusively. A few grain hulls in one stomach probably came from waste material.

The food for June, as learned from examination of eight stomachs, gives a good idea of what may be expected of the killdeer under favorable conditions. The weevil formed nearly a third of the monthly food, and was present in all of the stomachs but one. Of two birds which had destroyed surprisingly large numbers of the insect, one, from a newly cut field, had eaten 9 adults and 307 larvæ, and the other, feeding under similar conditions, had made away with 7 adults and 376 larvæ. A third had taken 42 larvæ and 1 adult.

Of other animal food items for this month ground beetles occurred in the greatest quantity. They were present in 6 of the 8 stomachs and comprised over 15 per cent of the monthly food. Snails were eaten extensively by two of the birds. Darkling beetles of the genus *Blapstinus* were frequently taken and formed nearly 11 per cent of the stomach contents. Dung beetles (*Aphodius*), bill bugs (*Sphenophorus* sp.), caterpillars, and wasps were other common ingredients. The vegetable portion was again unimportant, consisting entirely of weed seeds and rubbish.

The killdeer in no part of its extensive range is known to injure farm produce. The worst that can be said of it is that in its indiscriminate destruction of insects it may pick up a few that are beneficial. These, however, form an extremely small proportion of the bird's fare, while serious pests, as mosquitoes, craneflies, grasshoppers, and weevils of various kinds, are frequent components of its food. In addition to this already exceptional record, the killdeer must be considered as one of the most effective destroyers of alfalfa weevils. In early spring the birds are frequent visitors of infested fields, where many breeding weevils fall victims to the birds' voracity. The killdeer has been rightly removed from the class of game birds, where formerly it could be shot throughout much of its range. It may now continue its good work unmolested.

VALLEY QUAIL.

(*Lophortyx californica vallicola.*)

The valley quail, common in the irrigated portion of Salt Lake Valley, is frequently seen about alfalfa fields. Though a little shy in such environment, it appears to be perfectly at home and succeeds in raising broods wherever it finds sufficient cover. An open season is maintained for taking this bird during the month of October in the counties of San Pete, Uinta, Salt Lake, Davis, Weber, Utah, Sevier, and Carbon, while in some of the less densely populated sections a longer season is provided.

The valley quail has a good record as a weevil destroyer, based on a limited amount of material, but examination of it gives a fair idea of what can be expected of this bird. One was obtained in May and four in June. In the stomach of each the weevil was present in very large numbers, and in only one did the insects number less than 100 individuals in various stages of development. The five birds had eaten, respectively, 165 larvæ and 7 adults, 126 larvæ and 1 adult, 317 larvæ and 2 adults, 128 larvæ and 1 adult, and 75 larvæ and 2 adults, a total of 811 larvæ and 13 adults. In bulk this averaged 32.4 per cent of the stomach contents and at the same time formed 95.3 per cent of the animal portion of the bird's diet. In three cases the contents of the crop, which was full, were also included. Other animal food taken was divided in small lots under several heads.

The vegetable element, which formed 66 per cent of the stomach contents, was composed largely of weed seeds. Among these were found filaree (*Erodium cicutarium*), smartweed (*Polygonum* sp.), shepherd's purse (*Capsella bursa-pastoris*), Russian thistle (*Salsola tragus*), a vetch (*Astragalus* sp.), and dandelion (*Taxaracum taxaracum*). One bird had picked up about 400 seeds of alfalfa and another a quantity of wheat, estimated to be 55 per cent of the food.

Thus the valley quail may become troublesome by feeding on grain or seeds of other cultivated crops. At present, however, it is not sufficiently abundant in Utah to be a source of anxiety, and the short open season now allowed is more than ample to keep it in check. This bird is one of the most valuable about the farm, and in Utah it appears to eat even more than its customary amount of animal food. Any change in legislation, therefore, should be in the direction of increased protection.

WESTERN MOURNING DOVE.

(*Zenaidura macroura marginella.*)

The reason for including the western mourning dove, an almost exclusively granivorous bird, among the weevil's enemies is based on the fragments of adults found in two stomachs. While this mourn-

ing dove can not be considered an effective enemy of the weevil, it renders service to man in the consumption of weed seeds, and as long as it does not become unduly abundant in grain fields its presence is desirable.

The vegetable food of the birds examined was largely weed seeds. Among these were those of amaranth (*Amaranthus blitoides*, *A. retroflexus* and *A. albus*), filaree (*Erodium cicutarium*), cockle (*Vaccaria vaccaria*), pigweed (*Chenopodium* sp.), ragweed (*Ambrosia artemisiifolia*), thistle (*Carduus* sp.), smartweed (*Polygonum* sp.), and sunflower (*Helianthus* sp.).

RED-SHAFTED FLICKER.

(*Colaptes cafer collaris.*)

The red-shafted flicker is sparingly distributed through the Salt Lake Valley, though the constantly increasing supply of suitable nesting sites caused by the growth of trees in the irrigated portion bids fair to increase its abundance.

Of the three birds examined, two had fed on the alfalfa weevil, a trace of an adult being present in each case. Ants, its favorite food, composed practically the entire contents of each of the stomachs. In one were no less than 390 adults and 190 pupæ of the small dark brown ant, *Myrmica scabrinodis*.

Although the flicker is the most terrestrial of woodpeckers it does little toward the reduction of the weevil, as it lives chiefly on ants. In this it doubtless is working for the best interests of man, as many large harvest ants of the West (*Pogonomyrmex*) do considerable damage to grain and forage, not only by cutting down the crop for a space of several feet about their domicile, but by building nests which menace the operation of the mower or reaper.

ARKANSAS KINGBIRD.

(*Tyrannus verticalis.*)

The Arkansas kingbird probably is the most abundant and evenly distributed flycatcher in the Salt Lake Valley. Though it is more at home in arid districts, the writer met it in great abundance about ponds where flying insects furnished ample food.

Of ten birds secured four had eaten weevils, but not more than three were found in any one stomach. The small number is probably due to the fact that flycatchers are necessarily limited in this work to the short period when the weevil is on the wing, as also are swallows. The small cicada (*Platypedia putnami*) was a favorite food of these birds.

SAY'S PHŒBE.

(*Sayornis sayus.*)

Only three stomachs of Say's phœbe were available for examination. In one a single adult weevil was found, a dark-colored and much-worn specimen which had hibernated. The remainder of the stomach contents consisted of a varied assortment of flying insects, among which were tabanid flies, a cricket, carrion beetles (*Silpha*), a blister beetle (*Cantharis*), and several Hymenoptera.

TRAILL'S FLYCATCHER.

(*Empidonax trailli trailli.*)

Traill's flycatcher is found in considerable numbers in willow thickets along streams and ditches in the Salt Lake Valley. Seven birds were obtained when conditions were most favorable for feeding on the weevil, but only two had fed on the insect, a single adult being eaten in each case. The aerial feeding habits of flycatchers as a family naturally limit their consumption of the weevil to the warmest of spring days or to the later season when the brood of the year takes wing.

The food taken most frequently was Hymenoptera, ants, wild bees, and a few parasitic forms. These were found in each stomach and comprised about 43 per cent of the contents. Flies of various kinds (17.5 per cent) formed the next most important item, and beetles, bugs, and Lepidoptera were eaten in lesser quantities.

DESERT HORNED LARK.

(*Otocoris alpestris leucolæma.*)

The desert horned lark, a hardy little bird of the open country, is an abundant resident throughout the Salt Lake Valley, especially in winter, when it is familiarly known by the name of snowbird. It is one of the earliest species to breed and frequently its eggs may be found when the ground is still white. In early spring horned larks often feed in the wind-swept stubble of alfalfa fields, when they come in contact with hibernating weevils. Though essentially a seed-eating bird, from May to July a considerable proportion of animal food, including the larvæ of the weevil, is taken.

Three of the four birds collected in April had fed on the insect, the adult form in each case, and it formed about 3½ per cent of their food, but only one stomach contained more than one individual. The remaining animal food was characterized by a large proportion of lepidopterous remains, most of which, however, was in a single stomach. The vegetable portion, forming over half of the food, was composed almost entirely of weed seeds.

Six birds taken in May had fed on the weevil, but the number of insects eaten could not be accurately determined, as much of the food was in an advanced stage of digestion. The adults and larvæ occurred in about equal proportions. One bird had fed upon this insect to the extent of 80 per cent of its food, another 70, and a third, which had devoured 13 adults, 48 per cent. An average of over 41 per cent of the food of the six birds consisted of alfalfa weevils.

Another noteworthy animal food was a considerable quantity of caterpillars, forming over 17 per cent of the whole. Ground beetles amounted to over 6 per cent, and grasshoppers 5 per cent. The animal portion of the horned larks' food for May was nearly three-fourths of the stomach contents. The vegetable part (26.5 per cent) was divided between weed seeds and wheat. This latter element formed about two-thirds of the vegetable portion and may have been secured from recently sown fields.

Each of five larks collected in June also had fed on the weevil, which formed 29 per cent of the food. One had taken 16 adults and 1 larva, and another 10 adults and 25 larvæ. In no case did the weevil form less than 10 per cent of the stomach contents, and in one it went as high as 60 per cent.

Hemiptera, Lepidoptera (caterpillars), and spiders figured prominently in the other animal food. Of the vegetable portion, weed seeds composed the bulk.

More extensive investigations have shown that with the exceptional cases where injury is done to newly-sown grain the farmer has little to fear from this bird. Its best service is in the reduction of the annual crop of weed seeds. The lark also consumes much insect food during summer months, and in Utah the alfalfa weevil has quite naturally entered into its diet. On fair days in early spring these insects are abundant in the stubble of alfalfa fields where horned larks are common, and the destruction of the weevil at this time is a very important factor in the reduction of the numbers of the annual brood. While the consumption of adults ($3\frac{1}{2}$ per cent in April) is rather low, it is believed that at this time of year the horned larks do the most good in their fight upon the weevil.

MAGPIE.

(*Pica pica hudsonia.*)

Though only locally abundant in the Salt Lake Valley, the magpie is one of the best known of the birds of Utah. As it is somewhat gregarious in habit, from 15 to 20 nests may be found comparatively close together. Upward of 40 nests were found in one stretch extending half a mile along a creek near Kaysville. As alfalfa fields

flanked both sides of the stream, whatever was learned here concerning the magpie as a weevil enemy must be regarded as having been obtained under most favorable conditions.

Nestlings.—A series of 134 stomachs of nestlings was secured in May, and in 79 the weevil was found. It usually occurred in small numbers, the average for the lot being 4.8 weevils per bird, which amounted to 2.42 per cent of the food. Some, however, had eaten considerable numbers of the breeding adults. A half-fledged young had been fed 74 of the insects, and 5 others had eaten, respectively, 62, 55, 33, 26, and 24.

Examination of these stomachs shows how omnivorous are these birds, no less than 85 different items being recognized, besides large quantities of carrion and rubbish. In the material identified were six orders of insects, spiders, a shrimp, mollusks, a reptile, batrachians, earthworms, three species of birds, four of mammals, and seeds of eight species of plants. As each of these items has a different economic significance, the problem of the value of the magpie is complicated.

The largest animal food item was caterpillars (22.1 per cent), which occurred in 104 stomachs. Many of these were cutworms, gleaned from alfalfa fields along with the weevil. The remains of small mammals and carrion of many forms amounted to 14.75 and 11.86 per cent, respectively. Among the mammal remains were recognized meadow mice (*Microtus*), ground squirrels (*Citellus mollis*), a gopher (*Thomomys*), and a shrew (*Sorex leucogenys*). Associated with the carrion were large numbers of muscid pupæ and larvæ, which comprised 16.34 per cent of the stomach contents. It appeared from some of the material that parent birds visited a carcass of a beef or horse and removed only dipterous larvæ and pupæ, leaving the putrid animal matter as a breeding ground for more of the same. The stomachs of many young birds were nearly filled with the dipterous remains, only a few black or brown hairs indicating the source of the food. Ground beetles formed 5.15 per cent of the food, and miscellaneous Coleoptera, members of the genera *Necrophorus* and *Silpha* predominating, 4.05 per cent. Other insect food was divided in small quantities under several heads.

Other components of the animal food economically highly important were the remains of chickens and wild birds and their eggs. The feathers of what appeared to be a young chicken were found in the stomachs of two young birds of the same brood while fragments of eggshell occurred in 22 of the 134 collected. The entire stomach contents of one young magpie consisted of eggshell and what appeared to be its partially incubated contents. Another stomach was about four-fifths full of similar material.

FIG. 1.—YOUNG MAGPIES.

[Late broods of these birds were fed on alfalfa weevil larvæ.]

FIG. 2.—STRAW-THATCHED CATTLE SHED, A FAVORITE NESTING SITE FOR LARGE NUMBERS OF ENGLISH SPARROWS.

[These sheds were doubtless an important factor in maintaining the abundance of these birds in rural sections of Utah. See p. 46.]

Three of a brood of five fully fledged young had divided the remains of a small passerine bird. Another had been fed on what appeared to be the remains of a young robin, while a third had eaten eggs of the same species. The vegetable food was mainly rubbish.

In June late broods of magpies (see Pl. I, fig. 1) were frequently fed on the larvæ of the weevil. Eighteen of twenty-five birds examined had eaten the insect at an average of 5.6 adults, 0.08 pupa, and 29.24 larvæ per bird, amounting to 6.6 per cent of the stomach contents. The largest quantities of these insects occurred in this series of stomachs. A brood of six nestlings, about four to five days old, was observed in a cottonwood near the border of an alfalfa field. This field had been cut one morning, and during the afternoon the parent magpies were noticed making numerous visits, and judging from the well-filled stomachs of the young birds, the old birds had made good use of their time. This brood had consumed 36 adults, 2 pupæ, and 677 larvæ, an average of over 102 individuals per bird. As the young had also eaten a varied assortment of other food, comprising at least 25 different items, the weevil formed only 18.7 per cent of the contents.

The remaining animal food for June was essentially the same as for May, save that grasshoppers, taken in considerable numbers, amounted to over 13 per cent. Three of a brood of five had divided the remains of a sparrow, while one of another hatch had eaten the eggs of a robin.

Adults.—Being a resident the year round, the magpie was frequently seen on cold, windy April days visiting alfalfa fields. It was at first thought that bits of carrion or field mice might be the attraction, but analysis of stomachs showed that the birds were making diligent search in the stubble and under clods of earth for the adult weevils. Each of five birds examined had eaten weevils. One had taken no less than 160 adults, while others had eaten 60, 55, 45, and 19 adults, respectively. These composed 26.2 per cent of the magpie's food.

The omnivorous nature of these birds is not revealed this early, when comparatively few articles of food are available. Carrion occurred in four stomachs, amounting to over 40 per cent. Bones of a batrachian were found in another. Of the vegetable food, the larger part (19 per cent) was waste grain.

Eight magpies were collected in May, but the stomachs of three were too nearly empty to be of use. However, two of these revealed traces of adult weevils. Each of the other five had eaten this insect in quantities varying from 2 to 50 per cent of the stomach contents, while one especially remarkable stomach contained 181 adult weevils. No grain had been eaten by these birds, but there was an increased

percentage of various insect items. Numerous pupæ of a muscid fly, as well as carrion beetles (*Silpha ramosa*), were found. Carrion occurred in four of the five stomachs and amounted to over a third of the food, while the remains of a freshly killed small rodent were found in the other. The stomachs of two birds contained fragments of hen's egg.

Each of the six adult birds collected in June had fed on the weevil to the extent of 9.67 per cent of their food. One had eaten 24 adults and 180 larvæ. In one stomach were feathers of a small bird. Ground beetles, caterpillars, grasshoppers, carrion, and a small rodent composed the bulk of the remaining animal food. The vegetable element (20.5 per cent) was divided about equally between wild fruit and rubbish.

Summary.—During early spring the adult magpie is valuable as a destroyer of weevils as they come out of hibernation. Complaints that it steals hen's eggs may be practically eliminated by the proper housing and screening of nesting fowls, but as long as hens are allowed to lay eggs promiscuously about the farm magpies will continue to reap their toll. The destruction of wild birds and their eggs is doubtless the strongest argument against the species. In view of its obnoxious traits, legal protection for the bird is not recommended.

LONG-CRESTED JAY.

(*Cyanocitta stelleri diademata.*)

Deductions as to the relation of the long-crested jay to the weevil were based on the examination of a single stomach. This bird was from a densely wooded creek bottom which afforded direct egress from the shrubby vegetation of its favorite habitat to the midst of an agricultural community.

Among the stomach contents were a single adult weevil, a dung beetle (*Aphodius*), a bee, a caterpillar, carrion, grain hulls, and a mass of dandelion seeds.

The favorite habitat of wooded hillsides and canyon slopes and the natural food preferences of the long-crested jay apparently preclude it from becoming very destructive to the alfalfa weevil.

WOODHOUSE'S JAY.

(*Aphelocoma woodhousei.*)

Woodhouse's jay is fairly common wherever dense scrubby vegetation along a stream provides its favorite environment. Three stomachs were examined and adult weevils were found in each, averaging 1 per cent of the food. Ground beetles, mast, and wheat were

other important components of the food, and in the stomach of one bird were fragments of eggshell.

In view of the numerous objectionable habits of the closely related California jay it does not appear wise to recommend protection for this bird as a weevil destroyer. At the same time it is not numerous enough in agricultural districts of Utah to make any injurious habits which it may possess noticeable.

BOBOLINK.

(*Dolichonyx oryzivorus.*)

The bobolink, songster of hayfields and low meadows, is fairly common in Utah. It was found in moderate abundance in the vicinity of West and South Jordan, and Farmington, and along the Weber River and Chalk Creek in Summit County.

As a destroyer of the weevil it has an interesting record. In the stomach of each of the nine birds examined the insect was present in considerable numbers. A single bird collected in May had fed on 10 adult weevils, which formed 14 per cent of the food.

Seven bobolinks collected in June had taken the weevil at an average of about 8 adults and 42 larvæ per bird, to the extent of 68 per cent of the stomach contents. In the stomach of one, 6 adults and 90 larvæ formed the entire food. Another had eaten no less than 28 adults and 77 larvæ, amounting to 86 per cent of the stomach contents, while a third had eaten 3 adults and 61 larvæ. The only other food items in the last stomach were small fragments of a bug and a click beetle, estimated at 1 per cent. These birds also had fed to the extent of over 16 per cent of their food on caterpillars, which occurred in all but one of the stomachs. Bugs (Hemiptera) formed about half that amount.

A single bobolink collected in August had eaten 7 adults, which totaled 15 per cent of its food, while several caterpillars and lepidopterous pupæ formed an additional 71 per cent.

The bobolink does exceptionally good work as a weevil destroyer, for whenever it lives near infested alfalfa fields the insect forms its most important animal food. There appears to be no reason why it should not be fully protected. Its status in Utah is essentially the same as in the New England and other Northern States, where its economic merits have never been questioned.

COWBIRD.

(*Molothrus ater ater.*)

Previous investigations[1] of the economic status of the cowbird have shown that, judged from its food habits alone, the farmer has

[1] Beal, F. E. L., Food of the Bobolink, Blackbirds, and Grackles. Bull. 13, Biol. Survey, U. S. Dept. of Agr., 1900.

little to fear from this bird, but the fact that in its egg-laying habits it is parasitic, and frequently so on highly valuable species, has so complicated matters that its exact relation to agriculture is not yet thoroughly understood. In spring and summer the cowbird may be found usually in numbers of from two to six associated with one or more of its relatives in the vicinity of pastures or alfalfa fields. The cowbird's exceptional record as a weevil destroyer does much toward redeeming it for misdemeanors arising from its parasitism. Of the 15 birds collected only 1 had failed to feed on the insect.

Three cowbirds taken in May had eaten the weevil to the extent of over 60 per cent of their food. In one case it amounted to 95 per cent and was present at an average of about 7 adults and 30 larvæ per bird. Dung beetles (*Aphodius*) formed the bulk of the remaining animal food. Wheat, which was present in two stomachs, was estimated to be a fourth of the monthly sustenance.

Ten birds collected in June showed a continuation of the good work started in the preceding month. The only bird failing to eat the weevil was one which had taken three or four nymphs and one adult of the small cicada (*Platypedia putnami*), which formed nearly the entire stomach contents. The weevil, constituting 42.3 per cent of the food, was taken at an average of 6 adults, 1.4 pupæ, and 30.3 larvæ per bird. The largest number recorded for the species was 80 larvæ, 3 pupæ, and 3 adults, forming 80 per cent of the food. Of the remaining animal food Hemiptera was the most prominent item (18.7 per cent), and was composed of about equal parts of cicadas (*Platypedia*) and tree hoppers (Membracidæ). The vegetable food (27 per cent) was composed largely (18.3 per cent) of the seeds of weeds, among which were filaree, wild mustard, brome grass, and barnyard grass.

Two cowbirds taken in July had fed on the weevil, adults of the same year's brood in each case, to the amount of nearly 30 per cent of the stomach contents. The remains of a much-digested lepidopteran comprised about half of the food of one, and a mass of seeds of filaree, amaranth, smartweed, and sunflower formed about 80 per cent of the contents of the other stomach.

Summary.—The food habits of the cowbird in Utah during spring and summer appear to be above reproach. Grain forms but a small portion of its diet, while the alfalfa weevil is by far the largest ingredient of the animal portion. From the first of May to the middle of July the weevil forms over half the animal food, and much of the vegetable portion is composed of weed seeds. In recognition of the cowbird's work as a weevil enemy, it would appear that when every suppressive agency must be carefully conserved, the bird should be allowed to continue its good work unmolested by sportsman or small boy.

YELLOW-HEADED BLACKBIRD.

(*Xanthocephalus xanthocephalus.*)

The yellow-headed blackbird, or soldier bird, as he is more frequently called in the West, is the last of the three blackbirds to arrive in large numbers, although a few individuals are said to remain throughout the winter in favorable localities.

Nestling and juvenile birds.—As weevil enemies young yellow-heads do not rank as high as the nestlings of the other blackbirds. The insect amounted to 4.27 per cent of the stomach contents and occurred in 40 of 68 birds collected in June. Larvæ were preferred to adults, being taken on an average of 4.13 per bird, as compared with 0.74 for the latter. One nestling 4 or 5 days old had destroyed 48 larvæ, and a brood of three had eaten, respectively, 42, 25, and 40.

The work of a colony of about 15 or 20 yellow-heads upon an alfalfa field of three or four acres came under the writer's observation. The breeding marsh was fully half a mile from the source of food supply, and the flight of the parent birds to and from their nests was observed for about a half hour, during which the adults made visits to the fields at the rate of about one every minute.

Other animal food of the young, strongly indicative of the aquatic environment in which the bird lives, was dragonflies and their nymphs, which formed 43.86 per cent of the stomach contents, and occurred in all but 10 of the 68 stomachs. Some stomachs contained fragments of adult Odonata, which testifies to the ability of these birds to capture insects generally supposed to be effectively protected by their powers of flight. Caterpillars formed about a fourth (24.08 per cent) of the food. Ground beetles (5.7 per cent), spiders (5.54), grasshoppers (4.09), snails (3.76), and Hymenoptera (2.1) were the principal other ingredients of the animal food. The vegetable portion (2.13) was mainly rubbish.

Two juvenile birds collected in July had eaten the weevil, one of which had taken 2 adults and 30 larvæ.

Adults.—During April and May only two adult yellow-heads were collected each month, a too limited number to allow definite conclusions, but it shows that the birds were already preying upon the insect. One collected on the 23d of April had eaten a single adult, while the bulk of the stomach contents consisted of caterpillars. This latter element also composed 97 per cent of the food of the other April bird. The two birds taken in May had fed upon the insect, having eaten three and seven adults, respectively, which averaged 10 per cent of their food.

Of 21 stomachs collected in June only 4 failed to contain the weevil. The insect formed 43.48 per cent of the yellow-head's food and was taken at an average of more than 6 adults and 47 larvæ per

bird. The largest number taken by any of this species was 190 larvæ and 2 adults. Another record was 160 larvæ and 2 adults. Three adults and 117 larvæ were eaten by one bird, while five others had taken more than 170 individuals apiece.

Of the other animal food Lepidoptera, in the form of caterpillars, is most important, amounting to nearly 31 per cent. These insects occurred in 15 of the 21 stomachs and in one constituted the entire food. Ground beetles (8.56 per cent), Hemiptera (4.95), weevils other than *Phytonomus* (4.24), and dragonflies (2.48) made up the bulk of the remainder. The vegetable food (1.2 per cent) was of no economic importance.

Seven birds collected in July show a decrease in the amount of weevils eaten and a corresponding increase in other food items, as grasshoppers, flies, and grain. Only two had eaten the insect, one having taken but a single adult, while the other had made away with 48. Grain amounted to nearly half (44.57 per cent) of the food, verifying the complaint against these birds at this time of the year.

Summary.—With the exception of the work of adult birds during the month of June, the yellow-headed blackbird can not be considered as among the more effective bird enemies of the weevil, but its uniformly good work on caterpillars during the entire season argues in its favor. Its strong liking for dragonflies is against it, and also there is little doubt that it lays heavy toll on ripening and shocked grain.

THICK-BILLED REDWING.

(*Agelaius phœniceus fortis.*)

The thick-billed redwing is a common breeder throughout the Salt Lake Valley wherever is found a clump of cat-tails, a favorite nesting site. As small marshes flank the Jordan River and the shores of Salt Lake, and are about other places where imperfect drainage has left a pool, the bird is fairly well scattered throughout the valley, and of the blackbirds ranks next in abundance to Brewer's.

Those birds which do not winter in the Salt Lake Valley arrive early enough to render valuable service in the destruction of weevils emerging from hibernation. In the spring of 1912 the writer found them fairly common, and the examination of one stomach secured on the 1st of April indicated that they were already at work on the insects.

Nestlings.—Thirty of fifty young redwings examined for June had eaten the insect, which amounted to 10.64 per cent of their food, and was taken on an average of 0.3 adult and 12.58 larvæ per bird. In several instances, where nesting marshes were situated near infested fields, large numbers of larvæ were eaten. A brood of three

had consumed 60 larvæ, 84 larvæ and 1 adult, and 100 larvæ and 1 adult, respectively. Another hatch of three had averaged 32⅓ larvæ apiece. Several other food items characteristic of these birds appeared with such regularity that the actual bulk of weevils in no case amounted to over 50 per cent.

Caterpillars formed the next most important item, totaling 27.38 per cent. Dragon flies (Odonata) and their nymphs, and snails, forming 9.84 and 6.46 per cent, respectively, were secured from the immediate vicinity of the nests. Spiders composed over 15 per cent, and ground beetles, with the genus *Amara* predominating, a little less than a tenth of the food. The major portion of the remaining animal food was divided about equally between aquatic beetles, bugs, flies, and grasshoppers. The vegetable food (6.84 per cent) was unimportant, as over half was rubbish taken accidentally with the food.

An observation for a period of an hour was made of a female redwing feeding a brood of four nestlings about three days old. The nest was situated in a clump of cat-tails with alfalfa fields not far distant. The parent bird divided her time between visits to the adjacent marsh and the near-by alfalfa, and made trips to the nest on an average of one every 3¾ minutes. Though the alfalfa was visited oftener than the marsh, the food of the nestlings was gleaned largely from the latter place, as over one-quarter of it was dragon flies and over half spiders, while the weevil amounted to but 7.25 per cent. The parent bird, however, had made good use of her time in the field, as her stomach contained 3 adults and 56 larvæ, comprising 45 per cent of the contents.

Adults.—The early warfare on the weevils by adult redwings is verified by examination of stomach contents, and although the insect formed but a small proportion of the bulk (4.94 per cent), it was present in 27 of the 36 birds used in this computation. Five of seven other stomachs, which were too nearly empty to be of use, also contained the insect. Weevils taken in April were breeding adults, and were eaten on an average of 2⅙ per bird. The highest number eaten by any was 13.

Of other animal food, caterpillars and fly larvæ, mostly aquatic, composed slightly more than 13 per cent each. Aquatic beetles formed nearly 3 per cent and ground beetles nearly 2, while several other items occurred in small quantities, none over 1 per cent. Vegetable matter formed 57.08 per cent of the food, over half of which was grain, while the rest was divided between weed seeds (18.78) and a little rubbish.

During the month of May adult redwings increased their work on the alfalfa weevil until it comprised about one-sixth of their food, occurring in 23 of the 32 stomachs examined and averaging 4.84

adults and 2.41 larvæ per bird. The largest number of weevils in any one stomach was 12 adults and 75 larvæ. Of the remaining animal food caterpillars formed the most important element (16.63 per cent), while aquatic fly larvæ, some of which were Tipulidæ, amounted to about a tenth of the food. Ground beetles (4.44 per cent) and weevils other than *Phytonomus* (2.25 per cent) were the only other items worthy of mention. Among the latter the clover-root curculio (*Sitones*) and several species of *Sphenophorus*, living on sedges, occurred repeatedly. The vegetable element amounted to 44.9 per cent, about two-thirds of which was grain. The rest consisted of weed seeds and rubbish.

In June, the period of greatest abundance of nestlings, these birds eat the largest proportion of weevils. While parent birds are obtaining food for their young, they are inclined to partake of much the same varieties. Of 42 birds examined only 2 had failed to eat at least a trace of the weevil, and it was taken on an average of 5.24 adults and 27.16 larvæ per bird. In bulk it amounted to 40.76 per cent of the stomach contents. One male had eaten 5 adults and 108 larvæ. A female had made away with 24 adults and 68 larvæ. A pair collected in a breeding marsh had taken, respectively, 12 adults and about 90 larvæ, and 2 adults and 100 larvæ. The records of a few others are 12 adults and 73 larvæ, 5 adults and 77 larvæ, 13 adults and 58 larvæ, 6 adults and 61 larvæ, and in each of two cases 6 adults and 60 larvæ.

Next in importance to the weevil came caterpillars, which composed 17.38 per cent of the food for June. Aquatic and ground beetles formed a little over 5 per cent each; flies (largely the larvæ of aquatic species) 4.29 per cent; and spiders 3 per cent. The vegetable portion (12.67 per cent) was largely grain.

In July one male devoured 2 adults and 10 larvæ of the weevil.

Summary.—While the adult redwing eats its largest amount of weevils (over 40 per cent) in June, its greatest worth as a weevil destroyer lies in the fact that it is among the earliest of the weevil-eating migrants, often preying on these insects when snow is still on the ground. The food habits of the young are also in the bird's favor.

WESTERN MEADOWLARK.

(*Sturnella neglecta.*)

The western meadowlark (Pl. II) is a familiar bird of the Great Basin, and judging from early records is becoming more numerous in Utah as time goes on. Being a resident the year round, it is a common visitor to alfalfa fields as soon as snow leaves, and is more frequently met during April and early May than later in the year.

WESTERN MEADOWLARK.

In April, 27 of these birds were collected, and the weevil, which was found to comprise one-sixth of their food, was present in all but seven. The insects taken were adults, and the average was 14.4 weevils per bird. One bird had taken 75 of these insects, another 60, and three others 51, 48, and 33, respectively.

Other animal food is important, as the largest single item was caterpillars, amounting to nearly 22 per cent. These insects were present in all but 6 of the 27 stomachs, and in several instances formed a considerable proportion of the food. In one 15 caterpillars formed three-fourths and in another an equal number composed about two-thirds of the stomach contents. Ground beetles, many of which were of the genus *Amara*, amounted to about one-eighth of the food. Hymenoptera, largely parasitic ichneumons, were eaten to the extent of 6.5 per cent, while weevils other than *Phytonomus*, scarabæid beetles, Hemiptera, and Diptera formed about 2 per cent each. Of the vegetable food (27.26 per cent) a considerable portion (15.89 per cent) was grain, while the remainder was weed seeds and a little rubbish.

During May an increased consumption of caterpillars appears to explain a decrease in the percentage of weevils. The larvæ, eaten on an average of 3.83 per bird, and adults at the rate of 7.58, totaled nearly 11 per cent of the bird's food. A male taken in May had destroyed the largest number of adults, 81 of the insects comprising 92 per cent of the stomach contents. Another had made away with over 70 larvæ and 32 adults, while a third ate 40 larvæ and 10 adults.

Caterpillars amounted to nearly a third of the month's food (31.66 per cent), occurring in all but seven of the stomachs collected, and frequently composing the major portion of the food. In one case a bird had destroyed at least 20 of these insects and in two others 16 and 15, respectively, were eaten. Ground beetles were found in all but 2 of the 29 stomachs and amounted to over a quarter of the food. In two cases over 20 of these beetles were found in the stomach. Among them were several of the genus *Calosoma*, doubtless beneficial, but on the other hand there were large numbers of several species of the genus *Amara*, which are injurious to vegetation. Orthoptera (grasshoppers and crickets) composed 6.83 per cent, Hemiptera and scarabæid beetles about 3 per cent each, and several other insects were present in small quantities. The vegetable element was materially less than in May, being only a little over 9 per cent, and about two-thirds of it was grain.

In June the meadowlark maintains about the same relation to the weevil as during the preceding month. There is, however, an increase in the proportion of larvæ eaten. Examination of 14 stomachs revealed an average of 4.78 adults and 11.93 larvæ per bird, which amounted to nearly an eighth of the food. One bird worthy of men-

tion had taken no less than 100 larvæ and 4 adults and another had eaten 44 larvæ and 27 adults. Other food items vary but little in their relative proportions from those of May. Caterpillars formed a little less than a third of the contents and ground beetles about a fourth. Hymenoptera, many of which were parasitic ichneumons, composed 6.5 per cent, spiders 4.7, and weevils of the genus *Sphenophorus* about 4 per cent. The vegetable element was of no importance.

By July the abundance of other insect food caused the meadowlark to greatly reduce the proportion of weevils taken. The insect was eaten by only one of five birds examined. This bird, a fully fledged young, had consumed 16 adults of the year's brood, which formed 22 per cent of its food, giving an average of 4.4 per cent for the material collected in this month. Ground beetles and grasshoppers were the most important of the other food items.

Summary.—As a weevil destroyer the western meadowlark renders its most valuable service during the early days of spring, when many breeding adults fall prey to its diligent search. Its fondness for ground beetles and caterpillars, especially cutworms, has a tendency to reduce the percentage of weevils eaten during the following months. The good it does in the destruction of caterpillars more than offsets the harm arising from the eating of ground beetles. As the latter are very abundant throughout alfalfa fields, and as many are of species of doubtful economic value, the bird should not be too severely judged on this score. Examinations show that the meadowlark, at least from April to July, is not a menace to grain in Utah. On the other hand, its being a resident the year round makes it a valuable asset as a destroyer of hibernating insects, especially the alfalfa weevil.

BULLOCK'S ORIOLE.

(*Icterus bullocki.*)

Bullock's oriole secures much of its food from trees, caterpillars being the largest single item. Although the alfalfa weevil in all its stages is found most frequently on or near the ground, it was present in each of seven stomachs collected. Two birds taken in June had fed on it to the extent of $8\frac{1}{3}$ per cent of their food, while in the following month it formed nearly twice that amount. One bird collected in July had eaten no less than 21 adults, equaling 30 per cent of its food. No larvæ were taken by these birds even though this form of the insect was in great abundance, so that the adults may have been captured either on the wing or upon the branches of trees which had intercepted their flight.

Of other animal food caterpillars are most important, and they occurred in four of the seven stomachs. One bird had fed almost

exclusively on these insects, there being only a trace of an alfalfa weevil. In bulk caterpillars formed over a third of the food during May and June. Hymenoptera, in the form of wild bees and ants, composed about a fourth of the contents of five stomachs. Vegetable food entirely of grain, which was probably waste, occurred in three of the stomachs collected in July, and formed about a fifth of the food for the month.

In spite of the accusation that Bullock's oriole injures peas and small fruit, its good qualities outweigh its harmful traits. It already has a favorable record as an insect destroyer, but we may now add the alfalfa weevil to the list of noxious forms eaten by this bird.

BREWER'S BLACKBIRD.

(*Euphagus cyanocephalus.*)

Brewer's, or the white-eyed blackbird (Pl. III), as it is commonly known in Utah, is the most abundant blackbird of the State. It is very evenly distributed throughout the Salt Lake and the Weber valleys. At a point east of Hoytsville a large tract of irrigated land, much of which is given up to alfalfa, lies rather isolated from the river valley proper and at an altitude of several hundred feet above it. Brewer's blackbirds nested abundantly at the lower level, and as soon as nestlings were hatched the parents began making regular trips to the badly infested fields above, adult birds being observed several times traveling considerably over half a mile between the alfalfa and the nest. Another colony made trips of about a third of a mile from their nests in the sagebrush to a portion of a field which was particularly badly infested. Later, parent birds brought their families to the infested fields, where, in flocks of 15 to 20, they spent the entire day.

Nestling and juvenile birds.—Under this head are included young birds of any age, from the nestling of a day or two to the fully fledged bird. Of 125 stomachs examined, 78 were for the month of June, 45 for July, and 2 for August.

In June the weevil formed 20.14 per cent of the stomach contents and was eaten by 60 of the 78 birds. Together these birds had caused the destruction of 231 adults and 904 larvæ, an average of 2.96 adults and 11.59 larvæ per bird. Though the weevil does not occur in such large quantities in this series as in those collected later, the following records are noteworthy: A fully fledged young bird had eaten from 45 to 50 adults and no less than 60 larvæ, comprising 87 per cent of the stomach contents. Another had taken from 15 to 20 adults and 60 larvæ. Sixty-four larvæ were found in the stomach of a nestling three or four days old, while four other nestlings had eaten, respectively, about 40 adults, 40 larvæ, 37 larvæ, and 31 larvæ and 1 adult.

The animal portion of the food of the young Brewer's blackbird at this time of the year is of economic importance and amounts to nearly 94 per cent. Conspicuous are caterpillars (mostly cutworms), which totaled 34.57 per cent, or over a third of the stomach contents. These insects, abundant in many fields and doubtless doing considerable injury, together with adult Lepidoptera, occurred in 59 of the 78 stomachs, in several cases amounting to over 90 per cent of the food. Ground beetles (Carabidæ) amounted to 11.45 per cent. While these beetles, as a family, are considered beneficial, being mainly predaceous, there are some which injure vegetation. This is especially true of the genus *Amara*, which made up the greater portion of this part of the food. Spiders were eaten freely by the nestlings and constituted 9.37 per cent of the food. Flies amounted to 7.34 per cent, while the remaining animal food was divided in small quantities among insects of several orders.

The vegetable food is of little importance at this time of the year, both from its character and relatively small proportion (6.08 per cent). Over three-fourths was of rubbish, which testifies to the voracious temperament of the young, while weeds and a little grain formed the rest.

The young Brewer's blackbirds obtained in July were fully fledged and were out of the nest picking up much of their own food. Of 45 birds only 2 had failed to eat the weevil, and in the remaining stomachs it amounted to 25.47 per cent of the food. An average of 11.47 adults, 0.24 pupa, and 25.53 larvæ, or over 37 weevils in one stage or another for every bird, was the record made by these juvenals. A few cases will illustrate the importance of these birds as weevil destroyers. One had eaten 229 larvæ, 7 pupæ, and 20 adults; another made away with 140 larvæ and 6 adults, and the record of a third was 4 adults and 150 larvæ. The abundance of adult weevils of the year's brood in the middle of July is indicated by the stomach of a young blackbird, which contained 95 insects in this stage. Another had captured 10 adults, 1 pupa, and 126 larvæ. Other interesting records are as follows: 94 adults; 1 adult and 60 larvæ; 26 adults and 45 larvæ; 21 adults and 35 larvæ; 3 pupæ and 63 larvæ; 3 adults and 50 larvæ; and 5 adults and 52 larvæ.

The weevil composed about one-third of the animal food during this period, which in turn amounted to 77.8 per cent of the total contents. Of other animal food Lepidoptera, mostly caterpillars, formed 13.18 per cent, a little less than two-fifths of the amount taken in June. Hymenoptera, many of which were parasitic, made up 11.29 per cent. Hemiptera, the bulk of which was composed of the small cicada, *Platypedia putnami*, formed 10.11 per cent. Ground beetles totaled 8.67, while the remaining portion was divided in small quantities under several heads.

BREWER'S BLACKBIRD.

The vegetable food, amounting to 22.2 per cent, becomes important in this month, as nearly two-thirds was of grain, mostly wheat, the rest consisting of weeds and rubbish.

By August most of these blackbirds had forsaken the alfalfa fields and were paying attention to grain. Such animal food as they needed was amply supplied in the season's crop of grasshoppers. Two stomachs secured are too few for accurate deductions, but both contained adult weevils, 25 and 12 respectively averaging 13 per cent of the contents. Grasshoppers made up 38.5 per cent, while the vegetable element, all of which was grain, amounted to 43.5 per cent.

Field observation and analysis of material collected indicate that the young of Brewer's blackbird hold a very high place among the enemies of the weevil. While the stomach contents may not show so high a percentage as in some other species, the size and voracious nature of the bird means that a large quantity of food is consumed. The other elements of its animal food also are highly in its favor.

Adults.—In the season of 1912 Brewer's blackbirds did not become abundant before the first of May. Only two adults were secured in April, one of which had eaten a single weevil. The other, taken in a cattle corral during a snow storm, had eaten nothing but grain.

In May 45 stomachs were collected, some of which contained surprisingly large numbers of these insects. Only four of the birds examined had failed to partake of this food, and its bulk amounted to 16.85 per cent of the stomach contents. The advancement in the life cycle of the weevil in the season of 1911 over that of 1912 is readily shown by this material. The 11 birds taken in the former year averaged 6.64 adults and 50.09 larvæ apiece, while those of 1912 had taken no larvæ whatever but had eaten 10.76 breeding adults apiece. A female collected in May, 1911, had eaten 25 adults and 246 larvæ, comprising 89 per cent of the food. This same bird also had eaten a grasshopper, a cricket, a caterpillar, and a clover-root curculio (*Sitones hispidulus*). A male taken in the same month had consumed no less than 10 adults and 200 larvæ, equaling 97 per cent of the food, while another had eaten 6 adults and 105 larvæ. While the material of 1912 did not reveal such large numbers, the work was confined entirely to the destruction of breeding adults. The highest number taken in May of the latter year was 50 adults. One bird had eaten 33, while five others had taken over 20 individuals apiece.

Caterpillars, with a percentage of 15.67, were the most important of other animal foods. Hemiptera, the greater part of which was the small cicada, *Platypedia putnami*, and carabid beetles, with the genus *Amara* predominating, composed about 6½ per cent each. Orthoptera, Hymenoptera, and Diptera about equally divided the balance of the animal food. The vegetable contents, amounting to 34.11 per cent, was largely grain, much of which doubtless was waste.

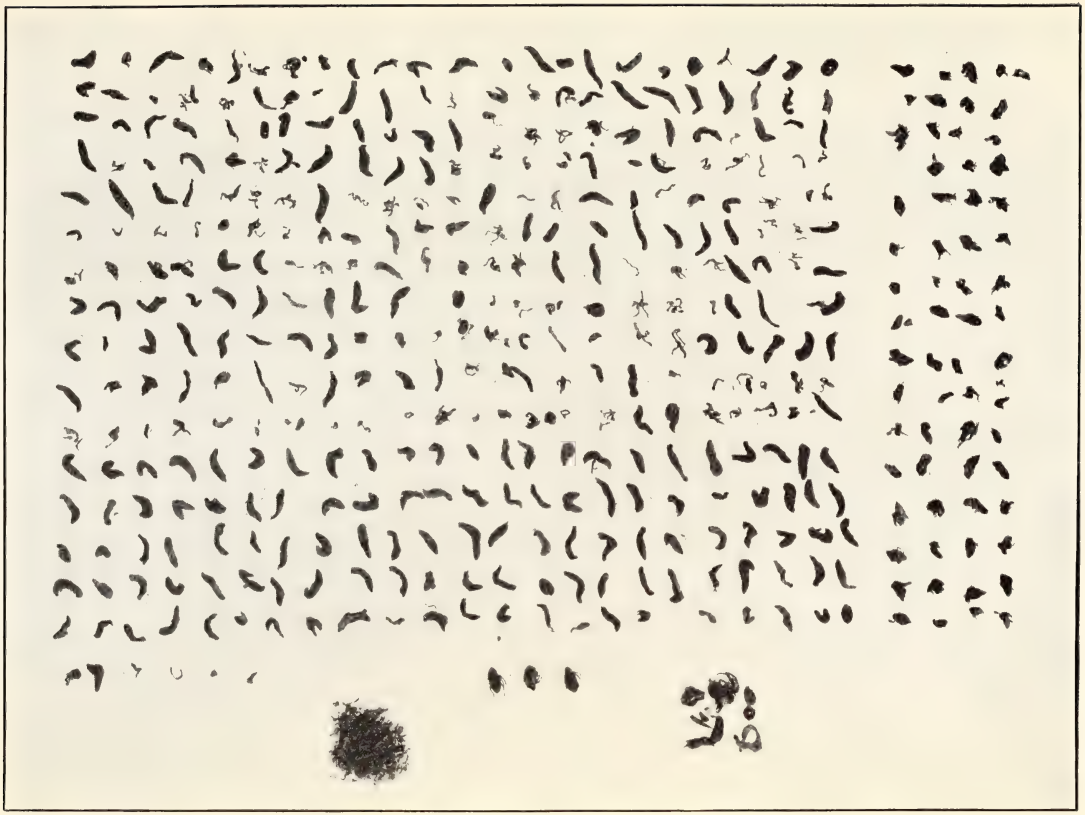
Adult blackbirds consume the largest proportion of alfalfa weevils in June, when the insect comprises nearly a third (32.70 per cent) of the food. Among the 99 stomachs examined are to be found records of the most remarkable work done by this bird. Only four had failed to eat the insect. The 99 birds together had made away with 580 adults, 68 pupæ, and 4,406 larvæ, averaging 6.4 adults, 0.7 pupa, and 48.9 larvæ, or 56 individuals per bird. Though this bird has a strong liking for insects of larger size, as cutworms and beetles of various kinds, the weevil formed the greater portion of the contents of many stomachs. In 11 cases it amounted to 90 per cent or more of the food.

A female secured from a post-breeding flock had devoured the largest number of weevils recorded for any individual bird—374 larvæ, 65 pupæ, and 3 adult weevils, a total of 442 individuals, comprising 96 per cent of the stomach contents. (See Pl. IV.) It also had eaten the larvæ of an aquatic beetle, a caterpillar, a dipterous larva, a nymph of a tree hopper (Membracidæ), two spiders, and a little rubbish, including a seed of filaree. Three birds had eaten, respectively, 281 larvæ, 268 larvæ and 6 adults, and 240 larvæ and 17 adults. In each case the weevil comprised 90 per cent of the food. Another had eaten 212 larvæ and 4 adults. In each of 14 other birds the combined number of larvæ, pupæ, and adults amounted to over 100, noteworthy among which was one containing 1 adult and 190 larvæ; another with 3 adults and 170 larvæ: and a third with 14 adults and over 140 larvæ.

Besides the weevils eaten during this month (32.7 per cent) the adult birds had taken nearly an equal quantity (27.83 per cent) of caterpillars. In seven stomachs this item made up over 90 per cent, while in one it formed the entire contents, the bird having eaten about 23 of these insects. Carabid beetles, Hemiptera, Orthoptera, and spiders formed the bulk of the remainder. The vegetable food, amounting to but little more than 5 per cent, was unimportant, as much was rubbish.

In July the depredations of these birds on the weevil are confined almost wholly to feeding on the adults of the year, which by this time are out in great numbers, especially in the vicinity of haystacks and along ditch banks, where they early seek places of hibernation. In one favorite resort of these birds about the base of a recently constructed stack, so many adult insects had fallen from the hay while the stack was being built that a brush of the hand in the debris at the base would disclose a squirming mass of hundreds which produced a distinctly audible "whir" in their scramble through the dry hay for new places of shelter.

During this month the weevil formed 20.26 per cent of the food, taken on an average of 12.45 adults and 1.79 larvæ per bird, and it was



STOMACH CONTENTS OF A BREWER'S BLACKBIRD.

[This individual had consumed the largest number of alfalfa weevils recorded for any bird—a total of 374 larvæ, 65 pupæ, and 3 adults, which comprised 96 per cent of the food.]

found in all but one of the stomachs. The highest number taken by any bird was 40 adults and 51 larvæ. This single stomach contained almost all the larvæ recorded for the adult Brewer's blackbird in July, which may be explained by the lateness of the season in the Weber Valley where it was collected. The contents of stomachs taken at this time in the upper valley corresponded to those taken three or four weeks previously in the vicinity of Salt Lake. Another bird had eaten 60 adults, while a third had taken 40. Eight birds collected in 1911 well show the character of the food when the weevil begins to disappear. Of the entire food 5.75 per cent was weevil while 91.5 was grasshoppers. Though much grain was being harvested in this region none was eaten by these birds.

Of animal food other than the weevil, grasshoppers are conspicuous, amounting to 27.2 per cent of the month's food. Caterpillars, ground beetles, and Hymenoptera, many of which were wild bees, comprised a little less than 10 per cent each. The rest of the animal food was divided in small quantities among several items of little economic importance. Of the vegetable portion (11.52 per cent), much was grain, the bulk of which was taken from the ripened crop.

Summary.—Brewer's blackbird, both old and young, is working for the best interests of the Utah farmer and in spring and summer is among the most effective bird enemies of the weevil. The adults appear to take slightly greater quantities of these insects than do the young, whose preference is for cutworms. Late in the season a marked liking for grasshoppers on the part of the old birds is also to their credit. About one-fifth of the food of both old and young during May, June, and July consists of weevils.

This bird is seldom shot or otherwise molested in Utah, where its economic worth is now fully appreciated, it having recently been afforded legal protection.

HOUSE FINCH.

(*Carpodacus mexicanus frontalis.*)

In Utah the house finch is probably the least insectivorous of all the finches, and in California has been much criticised because of its vegetarian habits. Primarily a seed-eating bird, it is true to its normal habits in Utah.

Nine of these birds were examined, but only two had eaten the weevil, the larval form in each case. One had taken two and the other three. Caterpillars, the only other animal food eaten, occurred in one stomach and composed about 15 per cent of the contents. The vegetable portion of the food consisted of weed seeds, of which three species were identified: Dandelion (*Taxaracum taxaracum*), shepherd's purse (*Capsella bursa-pastoris*), and smartweed (*Polygonum hydropiper*). Parts of other seeds were present, but, as this bird

is especially adept at hulling even the hardest and smallest of seeds, the partly digested embryos gave no clue as to their identity.

The house finch may render some service in checking the increase of the weevil by destroying adults early in the season, but owing to its almost exclusively vegetarian diet this must be small. Whatever worth this species has lies in its consumption of weed seeds.

PINE SISKIN.

(*Spinus pinus.*)

The stomach of the only pine siskin examined contained traces of an adult alfalfa weevil, but from what is known of its food habits in other parts of its range, this bird can not be regarded as important as a weevil destroyer. It is primarily a seed eater, and its animal food is confined mainly to such forms as plant lice and scale insects.

WESTERN VESPER SPARROW.

(*Poœcetes gramineus confinis.*)

The western vesper sparrow arrives in the Salt Lake Valley in March, when, during cold, blustery days, it may be found often in parties of three to six flitting about weed patches, usually not far from the protecting cover of a creek bottom. Later in the season it is a common breeder in the sagebrush areas adjacent to cultivated fields, and from here it makes regular trips to alfalfa fields in search of the weevil.

In April, 16 of these birds were collected in alfalfa fields. All but three had fed on adult weevils, which amounted to about a twelfth of the food. The small size of the stomachs means that in numbers the weevil will be limited. An average of a little less than two adult weevils per bird was maintained for this month, while eight weevils is the highest record of a single bird.

Other investigators have shown that the food of this bird varies from wholly vegetarian in midwinter to upward of 90 per cent animal during summer. In Utah insect life began to form an appreciable portion of the food in April, and amounted to a little less than a quarter of the stomach contents. A third of this was the alfalfa weevil. Of the other items the clover-root curculio (*Sitones* sp.) occurred frequently and totaled about 4 per cent of the contents. Fourteen of these were found in one stomach. Dung beetles (*Aphodius*) formed about an equal amount, while the remaining animal food was divided in small quantities under several heads. Of the vegetable food (76 per cent) about 19 per cent was grain and 57 per cent weed seeds. The latter element was present in all but one of the stomachs and in four instances formed practically the entire con-

tents. Among the weed seeds were those of filaree (*Erodium cicutarium*), sunflower (*Helianthus* sp.), pigweed (*Amaranthus retroflexus* and *A. blitoides*), cockle (*Vaccaria vaccaria*), smartweed (*Polygonum* spp.), panic grass (*Panicum* sp.), and brome grass (*Bromus* sp.).

Four vesper sparrows were collected in May, three of which had eaten the weevil, the fourth having been secured in a wooded ravine some distance from the nearest field. The weevil formed nearly 40 per cent of the stomach contents of the four, with an average of about three adults and six larvæ per bird. In the remaining food, caterpillars (8.25 per cent), grain (11 per cent), and weed seeds (42 per cent) predominate.

Examination of a series of 19 stomachs in June shows that these fringilline birds are decidedly insectivorous during the breeding season. Every one had fed on the weevil, and in 4 it amounted to over 95 per cent of the food, while the average for the month was nearly 60 per cent. As many birds were collected at a time when the larvæ were most abundant, this form of the insect appeared in large numbers in some stomachs. An average of 3.8 adults and over 24 larvæ per bird was recorded. One bird had eaten 2 adults and 60 larvæ, another 6 adults and 55 larvæ, and a third 1 adult and 50 larvæ. The weevil contents of several others are as follows: 5 or 6 adults and about 45 larvæ; 2 adults and 45 larvæ; 1 adult and 40 larvæ; 7 adults and 28 larvæ; and 10 adults and 21 larvæ.

Of the other animal food items Hemiptera, composed chiefly of the small cicada, *Platypedia putnami*, so abundant in the oak chaparral of the foothills at this time of the year, formed the next largest portion (7.79 per cent). Clover root curculios (*Sitones*), "bill bugs" (*Sphenophorus*), caterpillars, parasitic Hymenoptera, and grasshoppers follow in the order named. The vegetable portion (10.63 per cent) is divided between grain and the weed seeds previously mentioned.

For the month of July a larger series of stomachs (44) affords added evidence of the remarkable work of these sparrows as destroyers of the weevil. Only one had failed to feed on the insect. There was an increase in the average number of adults taken (5.36) and a decrease in the number of larvæ (18.43) as compared with the preceding month, because of the presence of more adults of the year's brood during July. Animal food comprised 73.02 per cent of the contents, 52.09 per cent being weevils. One bird had eaten 65 larvæ and 2 adults and was carrying 17 larvæ of the weevil in her bill for her young. Another had taken 46 larvæ and 22 adults. The stomach of a full-fledged sparrow collected in July, and still being fed by its parents, contained 45 larvæ and 8 adults. Eighteen other birds had

eaten 25 or more weevils in one stage or another, and 3 had also eaten a few pupæ.

Of the remaining items of animal food, caterpillars (5.59 per cent), ground beetles (4.2), and Hemiptera (mainly the small cicada, *Platypedia putnami*) (4.09) were most conspicuous. Weed seeds again were prominent, amounting to 22.3 per cent, while grain formed about 4½ per cent.

Summary.—Though the individual vesper sparrow is unable to consume as many of the insects in question as some of his larger and more voracious neighbors, as Brewer's blackbird or the robin, its economic relation to the weevil is nevertheless important. During June and July it subsists on the pest to the extent of over half of its food, while from a fifth to a third more is composed of other equally injurious insects, together with weed seeds. The grain eaten is doubtless mainly waste. These birds, whose natural home is in the dry sagebrush areas, probably are just beginning to discover the food supply obtainable in alfalfa fields. As they become more accustomed to visiting the alfalfa, we may expect them to render still greater service in the suppression of the pest.

WESTERN SAVANNAH SPARROW.

(*Passerculus sandwichensis alaudinus.*)

The western savannah sparrow is to the average person an inconspicuous individual in the bird life of Utah, even though fairly abundant in many sections. It is frequently met in the Salt Lake Valley, but is much more common in the valley of the Weber, where in some fields it is the most abundant of the sparrows.

In May, 1911, seven savannah sparrows were obtained. All but one had fed on the weevil, and this pest composed 72.42 per cent of the stomach contents. The larvæ apparently were preferred, for, although adult weevils were common, they occurred at an average of only a little over one per bird, while the larval form was found at the rate of 21 in every stomach. One had eaten no less than 61 of the green worms, the highest number recorded for the species.

The remaining food, which, save a mere trace of rubbish, was entirely animal in character, verifies the claim that this bird is one of the most highly insectivorous of sparrows, and that "they take equal rank in this regard with such notable insect destroyers as the catbird, robin, and bluebird".[1] The food other than weevil was decidedly in the bird's favor as a large part was caterpillars, fly larvæ, plant lice, and some unidentified coleopterous larvæ.

[1] Judd, S. D., The Relations of Sparrows to Agriculture, Bull. 15, Biol. Survey, U. S. Dept. of Agr., 1901.

Five stomachs of this species were available for June, and in every one the weevil was found. A large quantity of caterpillars in two stomachs reduced the percentage of weevils taken, but the results show that in this month the savannah sparrow is continuing the good work started earlier in the season. The weevil composed 37.4 per cent of the stomach contents and an average of a little over 1 adult and 11 larvæ were taken by each bird. The other food, again almost wholly animal, contained, besides nearly 30 per cent of caterpillars, a quantity of spiders, estimated at a little over a fifth of the food. This latter item was present in four of the five birds and was practically the only food which could not be considered in the bird's favor.

Nine stomachs collected in July reveal in a most striking manner the worth of this insectivorous sparrow as an enemy of the weevil. All of these birds had eaten the insect, and in six instances it amounted to 90 per cent or upward of the food, the average consumption for the month being 80 per cent. These birds were collected in the Weber Valley, where larvæ were very abundant, and they fed on the insect at the rate of 16½ larvæ and a little less than 2 adults per bird. The highest number eaten by a single bird was 26 larvæ and 1 adult.

Of the remaining food Hemiptera formed the largest portion (7.67 per cent). Included here are many small bugs of the genus *Corizus*. Caterpillars composed about 5½ per cent. The vegetable portion, 2.22 per cent, was entirely weed seeds.

Summary.—Of the native sparrows of Utah probably none can equal the western savannah as a destroyer of the alfalfa weevil, unless, under favorable conditions, it may be the western chipping or Brewer's sparrow. It not only appears to be the most highly insectivorous of the fringilline birds in this area, but also includes in this diet more than an ordinary share of weevils. During May, June, and July this insect forms from a half to two-thirds of its food, sufficient evidence in itself to induce every farmer to become familiar with the savannah sparrow and encourage its presence about infested fields.

WESTERN LARK SPARROW.

(*Chondestes grammacus strigatus.*)

The lark sparrow, one of the most robust and conspicuously marked of western sparrows, is found in abundance throughout the Salt Lake and Weber Valleys, and occurs in approximately the same numbers wherever found. It is frequently seen about alfalfa fields, and is one of the effective bird enemies of the weevil.

It is common by the first of May, and the 14 birds collected in this month show that they already were capturing breeding adults.

Weevils composed nearly 24 per cent of the lark sparrow's food and were present in all but one of the stomachs examined. With the exception of one bird collected in the season of 1911 all had been feeding on the adult form of the insect, it being eaten at an average of over five apiece. Fifteen was the highest number taken by a single bird.

About half of the remaining animal food (7.3 per cent) was caterpillars, with click beetles (Elateridæ) and clover-root curculios (*Sitones* sp.) next in order. The vegetable portion, 62.5 per cent, was divided between grain and weed seeds. The former, composing about two-thirds of it, may, to a certain extent, have been picked up from newly sown fields, but no serious complaints have been made against this bird.

Six lark sparrows collected in June show a considerable increase in the amount of weevils eaten (31.2 per cent). The insect was present in each of the stomachs at an average of about 7 adults and 7 larvæ per bird. In one the 4 adults and 30 larvæ present formed 77 per cent of the food. Caterpillars and grasshoppers, totaling about 14 per cent each, are the most important of other animal food items. The clover-root curculio (*Sitones* sp.), which is abundant in many sections, was present in small numbers in four of the six stomachs. The vegetable portion was again characterized by waste grain, which composed nearly a third of the contents.

In July the insect formed nearly 30 per cent of the food and was eaten by each of the 11 sparrows secured at the average rate of about 7 adults and 7 larvæ, the same as for the preceding month. The best record for the month and for the species was 13 adults and 49 larvæ, while the bill of the bird eating them contained 6 additional larvæ. Caterpillars, occurring in seven stomachs, were next in importance and composed 16 per cent of the remaining animal food. The vegetable element, which formed nearly half of the food, was, as in the two preceding months, noteworthy for its high proportion of grain (45.5 per cent).

A single bird collected in August had eaten several adults of the year's brood, amounting to 8 per cent of its food. The remaining portion of the stomach contents was entirely wheat.

Summary.—The claim that the lark sparrow is a greater lover of grain than most other native sparrows[1] is apparently substantiated by the writer's work in Utah. It is quite possible that some grain is secured from newly sown fields or from the ripening or shocked crop, but no noticeable losses have been attributed to this bird. As an effective enemy of the weevil the lark sparrow must not be over-

[1] Judd, S. D. Relation of Sparrows to Agriculture. Bull. 15, Biol. Survey, U. S. Dept. of Agr., 1901.

looked. Though its animal food is somewhat less than that of most of its relatives during the summer, in May, June, and July this bird showed a marked preference for the weevil. It was taken more frequently than any other food item, and formed about 57 per cent of the animal food.

WHITE-CROWNED SPARROW.

(*Zonotrichia leucophrys leucophrys.*)

The white-crowned sparrow is a common migrant throughout the Salt Lake Valley and breeds in the higher parks of the Wasatch. The single bird available for this investigation was secured in May, and its stomach contained the remains of one adult alfalfa weevil. Though not an extensive insect eater the white-crowned may assist in reducing the weevil during spring months.

WESTERN CHIPPING SPARROW.

(*Spizella passerina arizonæ.*)

Only eight stomachs of western chipping sparrows are available for examination. One each was taken in May and June, and six in July. Of these only one, a bird collected near Salt Lake City, in May, 1911, had failed to eat alfalfa weevils. This bird had fed almost exclusively on plant lice. The bird taken in June had eaten 38 of the weevil larvæ, composing 98 per cent of the food, while five lepidopterous eggs made up the balance. Each of the six birds collected in July had fed on the insect at an average rate of about 1 adult and 17 larvæ apiece. These composed 76.5 per cent of the monthly food, and in one instance comprised the entire contents of the stomach, 32 larvæ being needed to fill it. The stomach containing the smallest quantity (12 per cent) had three-fourths of its contents composed of weed seeds. Of two birds which were evidently feeding young, one had in its bill 6 larvæ of the weevil, and the other had 8 larvæ and a caterpillar. Of animal food other than weevils, bugs and spiders were most prominent and the vegetable element of 12.6 per cent was entirely weed seeds.

Too few chipping sparrows were examined to allow a general conclusion, but its habits apparently justify placing this bird on a par with its close relative, Brewer's sparrow, in its relation to the alfalfa weevil. The larvæ of the weevil are suitable both in size and availability as food for a bird of this character. Examination of a larger series of stomachs probably would show that the chipping sparrow feeds on the weevil to the extent of upward of four-fifths of its food during the months of the greatest abundance of the insect.

BREWER'S SPARROW.

(*Spizella breweri.*)

Brewer's sparrow, or the little sagebrush chippy, as it is sometimes called, has, like several of its close relatives, learned within the past four or five years that alfalfa fields afford an excellent supply of animal food. In some localities during May and June there is little to choose between the merits of this bird and the savannah sparrow as weevil destroyers.

Brewer's sparrow does not become abundant until May, and in this month 14 were obtained. Half of these were taken in the season of 1911 when the weevil larvæ were well advanced. These insects composed 43.43 per cent of the food, and occurred in all but one of the stomachs, averaging 2.2 adults and 6.9 larvæ per bird. Twenty-four larvæ was the largest number present in any one stomach.

The stomach of the bird which had not fed on the weevil was nine-tenths full of plant lice, a food item which occurred in 7 of the 14 stomachs, and amounted to over 38 per cent of the food. In one case these insects composed practically the entire contents (97 per cent). Caterpillars were present in five stomachs, forming 7.7 per cent. Spiders and miscellaneous beetles were estimated at about 3 per cent each, and the remaining animal food was of small quantities under several heads. The vegetable portion (1.1 per cent) was entirely weed seeds.

Each of the 15 Brewer's sparrows collected in June had fed on the weevil. Three were nestlings, but their food differed but little from that of adults. In only one instance did the weevil amount to less than a fourth of the food, while in one it composed the entire stomach contents, 25 larvæ being present. Three others were examined in which the weevil formed over 95 per cent of the food, these birds having eaten 17 larvæ, 19 larvæ and 1 adult, and 28 larvæ, respectively. The average of 0.4 adult and 15.3 larvæ eaten by these birds totaled nearly two-thirds (64.6 per cent) of the food.

Caterpillars superseded plant lice as the next most important food during this month, forming 14.5 per cent of the stomach contents, while the latter amounted to only about half that quantity. Spiders, the only other important component of the animal food, were eaten freely by four birds, giving a percentage of 6.13 for the month. Merely a trace of weed seeds was present.

In July 13 of the 17 Brewer's sparrows collected had fed on the weevil, but a decrease in the bulk was noted, it composing 44.8 per cent of the stomach contents as compared with 64.6 per cent for June. There was a slight increase in the number of adults eaten (0.6) and a corresponding decrease in the larvæ (11.8). The highest number of larvæ recorded for an individual of this species is 45. These com-

posed approximately 77 per cent of the food of this sparrow while the remains of a caterpillar and two pupæ of a moth added 20 per cent. One bird ate 3 adults and 18 larvæ, which comprised 94 per cent of the stomach contents, and it also carried 9 larvæ in its bill.

The other July food indicates a tendency toward a more vegetarian diet. About a fifth of the food was vegetable, while most important among the animal food items other than alfalfa weevils were caterpillars (11.9 per cent), Hemiptera, many of which were leaf hoppers (Jassidæ) (9.71), and spiders (2.12). The vegetable element was made up almost exclusively of weed seeds, dandelion and seeds of an unidentified grass occurring most frequently.

Summary.—Brewer's sparrow must be ranked among the most effective enemies of the weevil. During the height of the weevil season it subsists to the extent of over half its food on this pest. Other insects equally injurious, as plant lice and caterpillars, also fall prey to this bird. In the summer months upward of 90 per cent of its food consists of injurious insects and the seeds of weeds. The remaining tenth is composed of insects that are either neutral in their economic relations or indirectly beneficial to man. The amount of grain taken is insignificant.

DESERT SONG SPARROW.

(*Melospiza melodia fallax.*)

The desert song sparrow is one of the commonest of the native sparrows of Utah during the early spring months, when it may be found in the thickets along streams or irrigating ditches. Considerable numbers also pass the winter in favorable spots, which enables them to come in contact with hibernating adult weevils.

All but 2 of 11 birds collected in April had fed on the insect. Another bird whose stomach was too nearly empty to be of use in this investigation also had eaten weevils. In no case did more than 4 individuals appear in one stomach. In bulk they formed 7.35 per cent of the food.

Of other animal food the aquatic larvæ of stratiomyid flies composed the major portion, nearly 12 per cent. Caterpillars were present in two stomachs (7.27 per cent) and among other items which occurred in smaller quantities were spiders (5.45), dung beetles (*Aphodius*) (3.9), ground beetles (3.18), click beetles (2.72), and aquatic beetles (2.63). The vegetable portion was largely the seeds of weeds (31.18 per cent), among which were those of amaranth, pigweed, sunflower, ragweed, brome grass, and a sedge. Two birds had fed extensively on wheat, which brought the average for the month up to 16.45 per cent.

Two song sparrows collected in May had been doing good work on the weevil. In one, 5 larvæ and 1 adult formed 24 per cent of the food, while in the other 22 larvæ and 2 adults comprised about three-fourths of the stomach contents. Besides this the former had eaten a cricket and a large cutworm, and the latter two click beetles and a spider.

A single bird taken in June had destroyed 29 larvæ, which made up nearly two-thirds of the food; the rest of the contents included three click beetles, a caterpillar, three plant lice, two ants, a snail, seeds of three weeds, and a little grain.

As the song sparrow spends much of its time in early spring in localities selected by the weevil as places of hibernation, it must be looked upon as a valuable agent in the control of the pest. It also aids in the reduction of the number of larvæ later in the season. This bird, along with several other native sparrows, is frequently confused with the English sparrow, especially by the small boy engaged in killing the latter for bounty. This not only is one of the most potent arguments against a bounty system, but also reveals the need on the part of people generally of a more intimate knowledge of the appearance and economic value of insectivorous birds.

LINCOLN'S SPARROW.

(*Melospiza lincolni lincolni.*)

Lincoln's sparrow is a fairly common migrant in Utah, and was found in considerable numbers during April, often in company with its relative the song sparrow. Being almost entirely terrestrial in its feeding, it is seldom seen by the casual observer.

This bird renders its best service as an enemy of the weevil in destroying hibernating adults hidden in the localities it frequents in early spring. Each of three birds examined had fed on the insect, and it composed $8\frac{2}{3}$ per cent of the food. Adult insects were taken in every case and were eaten at an average of about two per bird. Among the remaining food were found the clover-root curculio (*Sitones* sp.), crane flies, aquatic beetles, and weed seeds.

SPURRED TOWHEE.

(*Pipilo maculatus montanus.*)

The spurred towhee is most common over the oak-covered foothills of the Wasatch, and wherever this growth extends to the close proximity of alfalfa fields it may be considered an enemy of the weevil. As it is a resident species and terrestrial in habits it comes in touch with hibernating adults. Only two of these birds were collected, both in April, and each had fed on the insect. One had eaten but a single adult, amounting to 1 per cent of its food, and the other had taken

at least 8, which comprised about an eighth of the stomach contents. Other food items highly in the bird's favor were seeds of brome grass, ragweed, and filaree; also the remains of click beetles, the parents of wireworms, were present in both stomachs.

As other investigations[1] have shown that the various subspecific forms of this towhee are, in other localities, of benefit to man, and since in Utah it was found to feed on the weevil, there is every reason for its conservation. Its greatest service as a weevil destroyer is rendered in the colder months.

GREEN-TAILED TOWHEE.

(*Oreospiza chlorura.*)

The older name of canyon finch is one that fittingly describes the habitat of the green-tailed towhee. Among the oak chaparral of the lower altitudes of the Wasatch this bird is often met, and as it frequently follows down the course of a mountain stream it may be found about the borders of alfalfa fields. This was observed many times in the valley of the Weber, but at no point in the irrigated areas of the Salt Lake Valley can the bird be called abundant. Six of the eight examined had fed on the weevil. One taken in May had eaten four or five adults (35 per cent) as well as a ground beetle, three darkling beetles, a hymenopteran, and a stinkbug. Another taken in June had the contents of its stomach too finely digested for accurately estimating percentages, but fragments of alfalfa weevils were recognized. Each of the other four towhees collected in June had fed on the insect, which formed an average of 57.5 per cent of the monthly food. One had destroyed 27 larvæ and 3 adults. Ground beetles, darkling beetles, Hymenoptera, and bugs were the more important of the other animal food items, while of the vegetable food weed seeds predominated.

This towhee's warfare on the weevil is conducted only in comparatively few fields located at favorable points in higher altitudes. Little though this may be, this bird should be carefully protected, especially since in other directions it is working for the best interests of the farmer.

BLACK-HEADED GROSBEAK.

(*Zamelodia melanocephala.*)

The black-headed grosbeak is a fairly common and rather evenly distributed species in the Salt Lake Valley, and is most frequently seen about the upper branches of shady cottonwoods.

[1] Beal, F. E. L., Birds of California. Bull. 34, Part II. Biol. Survey, U. S. Dept. of Agr., 1910.

Investigation of the food habits of eight of these birds, four of which were young, revealed that every one had fed on the weevil, though in some instances it amounted to only 1 per cent of the food. An adult taken in May had, besides one weevil and another beetle, the pulp and skin of an unidentified fruit. Three adult grosbeaks collected in June had subsisted on the weevil to the extent of 16, 1, and 95 per cent of their food, respectively. The first of these had eaten no less than 35 larvæ and 7 adult weevils; the second, 3 adults; and the third, 83 larvæ and 8 adults. Along with these were found remains of ground beetles, weevils other than *Phytonomus*, stinkbugs (Pentatomidæ), the small cicada (*Platypedia*), the seeds of weeds, and fruit of a hawthorn (*Cratægus*).

The four young grosbeaks were of the same brood, nestlings about two-thirds fledged. Their nest was located in a creek bottom flanked on one side by a badly infested alfalfa field. The consumption of weevils by these birds was at an average of 3 per cent for the brood, while 7 adults was the largest number taken by a single bird. The presence in the immediate neighborhood of large numbers of the small cicada, *Platypedia putnami*, may account for the relatively small proportion of weevils taken. The former insect occurred in each of the stomachs and averaged 88.5 per cent of the food. These young birds had also eaten small quantities of ground beetles, clover-root weevils, carrion beetles (*Silpha*), and a click beetle.

The number of stomachs available for this investigation is too limited to say how great is the work of the black-headed grosbeak as an enemy of the weevil, but the fact that each of the eight birds examined had fed on the insect indicates that it is picked up whenever found. Other investigations[1] have shown that with the exception of occasional depredations upon small fruit there is nothing objectionable in the food habits of this bird. When to its already favorable record we add the destruction of even a limited number of the alfalfa weevil, no doubt remains as to the economic, to say nothing of the esthetic, worth of this bird to the people of Utah.

LAZULI BUNTING.

(*Passerina amœna.*)

The lazuli bunting is frequently found about shrubbery along streams and on a few occasions was seen visiting the alfalfa in search of food. Only three stomachs were examined. One bird, taken in a wooded ravine some distance from the nearest irrigated fields, had failed to feed on the insect. The contents of its stomach were entirely vegetable, consisting of at least 60 seeds of *Montia.*

[1] McAtee, W. L., Food Habits of the Grosbeaks. Bull. 32, Biol. Survey, U. S. Dept. of Agr., 1908.

Two others had eaten the weevil, and in one of these 12 adults formed one-half of the contents while 5 adults and 29 larvæ in the stomach of the other composed 99 per cent of the food, a single seed of dandelion being the only other ingredient. The former of these had fed also on a cicada, a grasshopper, an ant, and a little grain. The lazuli bunting, aside from its esthetic value, is a bird of considerable economic importance. The products of the farm seldom enter into its diet, while among its customary food may be found the seeds of troublesome weeds and many noxious insects, including the alfalfa weevil.

CLIFF SWALLOW.

(*Petrochelidon lunifrons lunifrons.*)

With the exception of the rough-winged, the cliff swallow is the most abundant swallow in the territory covered by the present investigation. As enemies of the alfalfa weevil the most effective work of this and other swallows almost continuously on the wing is either at the time of the spring flight of the weevil or when the brood of the year takes wing later in the season.

Twenty stomachs of the cliff swallow were examined, three of which were of adults and the rest nestlings. The adults were collected early in June, when the birds were engaged in nest building and their stomachs contained 2, 6, and 8 adults, respectively, which formed about 12 per cent of the contents. Ground beetles composed over 40 per cent of the food. Besides these were found fairly large amounts of Hemiptera (bugs), Odonata (dragon flies), and aquatic, scarabæid, and other beetles.

In the stomachs of 17 nestlings collected later in the month the weevil formed but a part of 1 per cent of the contents, and was present in 7 of the 17 stomachs. In only one, however, did this insect occur in considerable numbers, that of a nestling about a week old which had been fed 21 adults. Another had eaten 5, and a third, 3.

As these birds were not far distant from extensive marshy areas, large quantities of the small aquatic beetle (*Helophorus lineatus*) were found in their stomachs. These had been eaten by each of the nestlings and formed about a sixth of their food. As many as 50 of these beetles were found in a single stomach. A small black ant occurred in each of the stomachs, in some cases in surprisingly large numbers, and in bulk it comprised a little over half of the young cliff swallows' food. The remains of flies of several species formed over a fourth of the stomach contents.

The work of all swallows upon the alfalfa weevil is confined to the two flight periods of the adult insect. During the earlier flight, when the life of the weevil is at its lowest ebb, any reduction of its num-

bers is of the utmost importance in suppressing the number of the season's brood. Though the cliff swallow does not arrive in Utah in abundant numbers much before the 10th of May many breeding alfalfa weevils may still fall as its prey. These birds feed on no product of the farm unless it is an occasional honey bee, but they include in their diet many of our most serious insect pests, noteworthy among which is the cotton-boll weevil in the Southern States.

BANK SWALLOW.

(*Riparia riparia.*)

The finding of two adult weevils in the stomach of a single bank swallow is the only evidence that this bird is among the enemies of the insect. Other elements in the food were numerous dung beetles (*Aphodius*) and several flies, including a syrphid.

ROUGH-WINGED SWALLOW.

(*Stelgidopteryx serripennis.*)

Over much of the alfalfa district of Utah the rough-winged is the most abundant of swallows. Nesting in banks of streams or railway cuts, they at times are in close proximity to infested fields.

Examination of twenty-one of these birds revealed the fact that the greatest consumption of weevils took place late in summer, when the year's brood had taken wing.

Of five birds collected in May, two had fed on the insect, which comprised 4 and 2 per cent, respectively, of their food. The remains of flies, some of which were of the genus *Bibio* (March flies), formed nearly two-thirds of the stomach contents, while small Hymenoptera and dung beetles (*Aphodius*) also figured prominently in the percentages.

During June only three of a series of eight had fed on the weevil, to an average extent of 1 per cent of the stomach contents for the month. Flies of various kinds were taken in considerable numbers and formed about three-fourths of the food. Small Hymenoptera were present in six of the stomachs.

In July the birds began to prey upon the flying adults of the year's brood. Six of the eight swallows examined had fed on the insect, which composed 23 per cent of their food. The weevils had been taken on the average of nearly 8 per bird, 18 being the highest number recorded from a single stomach. In this case it formed over a third of the contents, and in another 11 weevils made up nearly a half. Ants, found in each of the stomachs, amounted to over half of the swallow's food. Neuropterous insects were also detected in several cases.

No rough-wings were collected in August, but in all probability these birds continue to prey on the insect during late summer whenever a flight takes place.

The rough-wing probably is as effective an enemy of the weevil as the cliff swallow, but, like the latter, its work is limited to warm, fair days of spring and late summer. In addition to the good work of this bird upon this insect its economic status, based on other activities, is in its favor.

YELLOW WARBLER.

(*Dendroica æstiva æstiva.*)

The yellow warbler is the most common of breeding warblers throughout the Salt Lake Valley. Whenever its favorite nesting site of willows along the banks of streams and irrigating ditches occurs about the borders of alfalfa fields, this bird is brought in contact with the weevil.

Five birds were collected in June and two in July. Only those taken in the latter month were feeding on the weevil. One had eaten 11 larvæ and 1 adult, the other 6 larvæ. Besides, the latter had in its bill 3 weevil larvæ, a bug, and 9 flies. In bulk the weevil composed nearly a fourth of the food of the two.

The other yellow warblers had fed extensively on caterpillars, which were found in each of the stomachs and formed nearly 70 per cent of the food. One half-grown nestling had been fed exclusively on these insects. Small Hymenoptera, some of which were parasitic, were next in abundance, forming nearly a fifth of the contents.

Although abundant about the borders of alfalfa fields, yellow warblers were seldom observed dropping down to them in search of food. The upper branches of willows are their favorite resorts and apparently their food is largely secured from such places.

MACGILLIVRAY'S WARBLER.

(*Oporornis tolmiei.*)

Listing Macgillivray's warbler as an enemy of the weevil is based on the examination of only one stomach. Two breeding adult weevils eaten in May formed about 2 per cent of the contents. There were also present the remains of a click beetle, a dung beetle, a flea beetle (*Systena* sp.), and a large amount of unidentified insect fragments.

LONG-TAILED CHAT.

(*Icteria virens longicauda.*)

Our knowledge of the long-tailed chat as a weevil destroyer is based on the examination of three stomachs. In two the insect was present, one containing a mere trace of an adult, and in the other 2 adults composed about 3 per cent of the food.

The chat's food habits are strikingly like some of the flycatchers. Hymenoptera form a conspicuous element in its diet, as do also flies and other forms which the bird may secure from its favorite haunt in the tree tops. One bird had eaten six wild bees, aggregating 94 per cent of the food, and another had fed on the small cicada (*Platypedia putnami*), which formed about two-thirds of the stomach contents.

As a check upon the weevil little can be expected from the long-tailed chat, because of its arboreal habits. Its food is of little economic importance, much being of a neutral character, while a certain proportion of beneficial insects appears to offset the good it does in the destruction of noxious forms. The inestimable value of its wonderful song, however, is alone sufficient reason for the most careful preservation of the species.

SAGE THRASHER.

(*Oreoscoptes montanus.*)

The sage thrasher, a bird of the arid regions, arrives in the Salt Lake Valley about the middle of March, and its rather weak song may then frequently be heard about the edges of alfalfa fields bordering on sagebrush areas.

Examination of 10 stomachs showed that the sage thrasher feeds on the weevil to a considerable extent. In bulk it formed about an eighth of the food and was present in seven of the stomachs. The best work appeared to be done in June, when the insect was eaten at the rate of about 3 adults and 6 larvæ per bird. One bird had eaten 3 adults and at least 34 larvæ, which composed 44 per cent of the stomach contents.

Ground beetles were present in all but two of the stomachs examined and formed about 30 per cent of the food in June and a lesser amount in April and July. These beetles and a trace of an ant formed the entire contents of one stomach. Darkling beetles of the genera *Blapstinus* and *Eleodes* also were frequently eaten, composing a fifth of the food. Hymenoptera, spiders, and caterpillars were other important ingredients. The only vegetable food was a quantity of currants found in one stomach.

The sage thrasher can not be regarded as a very effective enemy of the alfalfa weevil, except when alfalfa fields extend toward its native haunts among the sagebrush. Under ordinary conditions its food habits are strongly in the bird's favor, but occasional complaints have been made that it injures small fruits.

LONG-TAILED CHICKADEE.

(*Penthestes atricapillus septentrionalis.*)

The long-tailed chickadee was frequently met along the borders of alfalfa fields and in the shrubbery of creek bottoms in irrigated

sections. Being a resident all the year, in early spring it could be found searching diligently over the branches and trunks of cottonwoods or flitting through dense thickets of hawthorn or willows. In such environment it is quite possible for the chickadee to come in contact with hibernating weevils.

Six birds were collected in April, and the weevil was present in the stomachs of three. Two of these contained 2 adults apiece, while the third had 3, and this food amounted to about 3 per cent of the stomach contents.

Much of the food of these small birds was very finely divided and in some cases unidentifiable. In three of the six stomachs, however, large numbers of plant lice were detected. Small lepidopterous cocoons also were found.

Even though the amount of food consumed by one of these birds is small, there is reason to believe that the chickadees secure many of those adults which make their winter quarters in crevices in the bark of trees.

WESTERN ROBIN.

(*Planesticus migratorius propinquus.*)

The western robin is a resident of parts of the Salt Lake Valley the year round, but in the more exposed situations and in the higher valleys surrounding Salt Lake it is a migrant and summer breeder. In the lower valley it becomes very abundant in April and early May, while a month or two later, though still common, it is most frequently found in the shade of orchards or in truck-crop areas, where the more thoroughly watered ground assures it a constant supply of one of its favorite foods—earthworms. In the valley of the Weber the robin was an abundant breeder and a frequent visitor to the infested alfalfa fields.

Forty-five birds were collected in April, but four stomachs, being nearly empty, were not used in the computation. Three of the four stomachs discarded, however, showed traces of the weevil. Of the others, 28 contained the insects, adults in every case, which comprised a little over 14 per cent of the food. This material gave an average of 5.63 adult weevils per bird. The best individual work done by any robin in this month is credited to a male, which had captured no less than 56 of these insects. Another had eaten upward of 20.

Caterpillars, many of which were cutworms, were taken with almost as great avidity as the weevil, occurring in 27 stomachs, but the larger size of these insects resulted in a much higher percentage, 23.24. One stomach contained at least 90 young caterpillars. Click beetles (Elateridæ) and their larvæ, wireworms, were found in 18 stomachs and amounted to 11.10 per cent of the contents. One bird

had eaten no less than 5 adults and 40 larvæ of *Limonius occidentalis*. The other more important elements of the animal food were earthworms (8.68 per cent), flies (5.97), dung beetles (Scarabæidæ) (5.70), and ground beetles (3.97). Carrion, unassociated with bone fragments to denote its origin, was found in several stomachs. The rather careless feeding habits of this bird are attested by a large amount of rubbish in the food. This occurred in 23 stomachs and amounted to nearly 12 per cent of the bulk. A little grain (2.10 per cent) also was eaten.

For the month of May only four stomachs are available. Each contained the weevil, totaling 7.25 per cent of the food. No very large numbers of the insect were recorded, but this is attributed to the limited amount of material. The other food items maintained approximately the same relative proportions as in April.

During June a series of 17 stomachs was collected largely about Coalville, in the Weber Valley, where these birds bred in considerable numbers. The weevil, present in 10 stomachs, composed 23.77 per cent of the food, and was taken at an average of about 2 adults and 42 larvæ per bird. Two birds had eaten exceptionally large numbers of the insect. One destroyed 2 adults and 253 larvæ, and the other 3 adults and about 241 larvæ; the latter composed 80 per cent of the food. Two other noteworthy records were 1 adult and 75 larvæ, and 5 adults and 40 larvæ, respectively. Caterpillars, again a prominent part of the food, were present in all but three of the stomachs and amounted to nearly a fifth of the contents. Ground beetles, darkling beetles (*Eleodes*), carrion beetles (*Silpha*), and carrion were the other prominent animal food items. Rubbish, comprising the bulk of the vegetable element, amounted to more than a fourth of the contents.

Examination of 18 robins collected in July showed a falling off in the amount of weevils eaten. Eleven birds had fed on the insect at the rate of 4 adults and 13.8 larvæ per bird and to the extent of 9.39 per cent of the monthly sustenance. One stomach contained 2 adults and about 220 larvæ. Caterpillars, still a conspicuous element (37.72 per cent), occurred in 12 stomachs. Earthworms made up nearly a fifth of the food, while ground, carrion, and darkling beetles maintained about the same proportions as in June. The only vegetable food other than rubbish worthy of notice occurred in a single stomach, which was filled with the skin and pulp of an unidentified fruit.

Summary.—As is the case with several other resident species the robin does its most effective work in early spring. Much of its time is then spent about the borders of alfalfa fields, where many weevils are emerging from winter quarters. Though the actual percentage for April (14.29) is less than two-thirds of that for June (23.77), there is no question that the good done is much greater in the earlier

month, when the rigors of winter have reduced the insect to its lowest ebb; and any agency in the work of destruction that can be brought to bear at this time is of the utmost importance. The food of the robin in Utah speaks highly in its favor. Some complaint was heard that it injures cherries, but this trait does not seem sufficiently uniform to offset the good it does. Until the weevil is reduced in numbers the services of the robin as a destroyer of breeding adults alone ought to earn for it the utmost protection.

MOUNTAIN BLUEBIRD.

(*Sialia currucoides.*)

The mountain bluebird is an abundant breeder throughout the higher altitudes of Utah and in spring and fall is a migrant in the irrigated valleys. In the spring flocks of 5 to 15 often may be seen in the vicinity of infested fields. In their search for food, usually confined to the borders of fields and along roadsides where fences and telephone poles afford favorite perches, the bluebirds come in contact with hibernating or recently emerged adult alfalfa weevils. A considerable number of bluebirds were encountered in April in the Salt Lake Valley, and in July they were found in post-breeding flocks in alfalfa fields in the Weber Valley. At the latter place the fully fledged young were feeding extensively on the larvæ, which were then present in great numbers.

Of seven birds collected in April five had fed on breeding weevils. In bulk the weevils composed over 4 per cent of the food and were taken at an average of about two and one-half per bird. Twelve was the highest number recorded for any individual.

The major portion of other animal food at this time of year consisted of caterpillars (32.5 per cent) and ground beetles (31.3 per cent). In one stomach eight cutworms formed about four-fifths of the food and in another a similar number composed over 72 per cent. Among the ground beetles the genus *Amara* predominated. Crickets appeared prominently in two, and in one a large number of dung beetles (*Aphodius*) formed about two-thirds of the food.

Each of the nine birds collected during July had fed on the insect, which amounted to 11 per cent of the food. One, a juvenile bird, had eaten at least 70 of the larvæ, forming 40 per cent of its food; another, 17 larvæ and 5 adults; and a third about 12 larvæ and 3 adults.

The remaining animal food of the bluebirds at this time was characterized by a large proportion of hemipterous remains made up largely of the small cicada (*Platypedia putnami*), so abundant among the oak chaparral of the foothills.

The mountain bluebirds, like many other spring and fall migrants, render their most valuable services as weevil destroyers in early spring. More extensive investigations of their general food habits

have established the fact that, as a family, they are among the most persistent of insect feeders and at the same time molest no product of the farm. Their presence should be fostered at every opportunity, and there is reason to believe that as our western country becomes more thickly settled these gentle birds may become as familiar about dooryards as are their eastern relatives.

ENGLISH SPARROW.

(*Passer domesticus.*)

From its enormous abundance throughout much of the weevil-infested region of Utah, as well as from the fact that, individually, it is a most effective enemy of the alfalfa weevil, the English or house sparrow must be placed very high in the scale of weevil enemies. There is no bird in which the people of Utah are more interested than this much-criticized foreigner and, as its efficiency as an insect destroyer has frequently been questioned, special pains have been taken to present as thorough a consideration as possible of the relation of the sparrow to the alfalfa weevil.

The English sparrow presents a problem in Utah somewhat different from that in many other parts of its range. Though by no means uncommon in the city streets, the never-ceasing chatter of hundreds of these birds heard along country roads and about farmyards readily makes an observer realize that in many rural sections of the Salt Lake Valley this species is by far the most abundant.

A factor partly responsible for this condition is the presence on almost every farm of one or more straw-thatched sheds for housing live stock and in these the birds nest. (See Pl. I, fig. 2.) These sheds are constructed usually with the ceiling about 8 or 9 feet from the ground. The framework is made of heavy logs overlaid with limbs and smaller boughs, and upon this the straw is placed to a depth of 2 to 5 feet. Into the straw the sparrows dig holes about the size of one's arm and sometimes extending inward for a foot or 18 inches. Masses of nest material also may be found placed upon the beams or limbs used in the framework. Frequently upward of 100 nest holes, both occupied and deserted, may be found in a roof about 20 or 30 feet in dimensions. Lombardy poplars, cottonwoods, and box elders, abundant in the valley, are also favorite nesting sites.

FOOD OF YOUNG BIRDS.

For investigating the food habits of young English sparrows 1,039 stomachs, mostly of nestlings, are available. These were secured as follows: First half of May, 16; second half, 530; first half of June, 382; second half, 36; first half of July, 40; and second half, 35. The bulk of this material was collected from the middle of May to the middle of June, which about coincides with the period of greatest abundance of these young birds as well as of the larval form of the weevil. The largest number was from the vicinity of Murray,

Midvale, West and South Jordan, Sandy, and Riverton, an area in which this bird is by far the most abundant species.

May 1 to May 15.—Examination of birds collected during this interval showed that the parent birds were already visiting alfalfa fields for food for the hungry nestlings. The weevils fed to the young were adults which had hibernated, a very important economic service when is considered the potential harm of each pair of weevils during the course of a season, as embodied in their progeny.

About one-half of the total animal food, 14 per cent, consisted of the weevil. Thirteen of the 16 birds collected had fed on this insect, indicating that this food is probably picked up whenever found. These nestlings had eaten a total of 218 adult weevils, or an average of $13\frac{5}{8}$ per bird. A brood of three, about 2 or 3 days old, had eaten 60, 50, and 32 per cent, representing 58, 41, and 28 weevils, respectively.

The contents of these stomachs consisted of 28.06 per cent animal and 71.94 per cent vegetable matter. Of the animal food other than weevils 4.19 per cent was caterpillars, while 4.37 per cent consisted of scarabæid beetles of the genus *Aphodius*. Ground beetles aggregated 2.56 per cent; Hymenoptera, 1.12 per cent; and Orthoptera (grasshoppers and crickets), slightly less than 1 per cent. The remaining portion of animal matter was composed of other insects in small quantities.

The largest portion of the vegetable food was wheat, found in 15 of the 16 stomachs, and amounting to 65.62 per cent.

May 16 to May 31.—The weevil was eaten by the 530 birds to the extent of 36.12 per cent of the stomach contents, which is the highest proportion of this food eaten in any of the semimonthly periods covered. As this figure was obtained from the examination of so large a series of stomachs, it doubtless is not far from a true representation of what these young birds do at this time of year. The remarkable persistency with which the parent birds seek this food for their young is well shown. Of 530 young birds, only 19, or 1 out of about every 28, had failed to eat the weevil.

Among the birds notable for their stomach contents were 7 in which the weevil composed the entire food, 11 in which it amounted to 90 per cent or over, and 16 in which it was 80 per cent or over. The number of insects that may be contained in the stomachs of these young birds is remarkable. A nearly fledged young of a brood of four had eaten no less than 20 adults and 110 larvæ, while the remaining three had consumed 27 adults and 29 larvæ together. Two young birds, about a week old, had eaten 62 adults and 92 larvæ between them. A brood of four, about 4 days old, had taken, respectively, 38 adults and 33 larvæ, 33 adults and 65 larvæ, 41 adults and 67 larvæ, and 25 adults and 60 larvæ, or an average of $34\frac{1}{4}$ adults and $56\frac{1}{4}$ larvæ apiece, equaling 51 per cent of the stomach contents. An-

other brood had eaten a total of 53 adults and 200 larvæ, averaging $10\frac{3}{5}$ adults and 40 larvæ for each bird. Four other young, about 2 days' old, had devoured 4 adults and 195 larvæ.

A brood of three, 3 or 4 days old, had taken a total of 210 adults and 12 larvæ from a badly infested field adjacent to the shed in which the nest was located. Another brood of the same number had eaten 190 and 15; a brood of two, 129 and 5; while three other young birds, 3 or 4 days old, had taken no larvæ, but had consumed 183 adult weevils. On May 27 the writer collected a brood of five young birds, 5 or 6 days old, whose stomachs contained a total of 308 adults and 151 larvæ, an average of 61.6 and 30.3 per bird, and amounting to 70.4 per cent of the contents.

Of the 530 stomachs collected for this period, there was one which contained over 100 larvæ, 7 which had from 75 to 99, 29 with from 50 to 74, and 90 with from 25 to 49. As to adult weevils, there were 5 stomachs containing from 75 to 99, 21 with from 50 to 74, and 74 with from 25 to 49. Many stomachs contained from 15 to 25 larvæ, as well as adults, the total frequently exceeding 40 individuals.

The food, other than weevils, next most important was Lepidoptera, comprising 18.36 per cent of the contents, and almost entirely made up of caterpillars. In 28 stomachs caterpillars composed three-fourths or more of the contents. Though at present these insects are not causing so much damage as the weevil, yet the good service of the birds in destroying them must be recognized. Ground beetles (Carabidæ) made up 4.65 per cent of the stomach contents, the principal portion being of the genus *Amara*. Diptera, made up largely of Tipulidæ (crane flies), comes next in order, with a percentage of 3.9. Spiders, eaten principally during the first 2 or 3 days of the nestlings' life, composed 3.78 per cent, and scarabæid beetles, mainly of the genus *Aphodius*, represent 2.75 per cent. Hymenopterous insects made up 2.08 per cent of the contents. The remainder of the animal food, a little less than 3 per cent, was scattered among several groups of insects, of which carrion beetles (Silphidæ), grasshoppers, and bugs (Hemiptera) were most important.

The vegetable food, as usual, was composed almost entirely of wheat and oats. Much of this must be considered waste, though some complaints that sparrows steal chicken feed are verified by this examination.

June 1 to June 15.—A percentage of 26.75 shows the extent to which the 382 young, examined in this period, were feeding on the weevil. A total of 4,907 adults and 5,336 larvæ were eaten, an average of 12.85 adults and 13.97 larvæ for each bird. In 1911 of 22 birds 3 had failed to feed on the insects, while in 1912 only 1 out of 360 did not eat them, this being a very young bird in which spiders and caterpillars formed much of the stomach contents.

Stomachs containing remarkably large numbers of these insects for so small a bird are to be found in this material. One brood of five half-grown young consumed, respectively, 55 larvæ and 1 adult; 110 larvæ and 2 adults; 95 larvæ and 3 adults; 85 larvæ and 4 adults; and 123 larvæ and 1 adult, an average of 93.6 larvæ and 2.2 adults for each bird. A brood of three averaged 5⅔ adults and 88 larvæ apiece, one of these having eaten 170 larvæ and 5 adults, the largest number recorded for a young of this species. Four young collected on June 1, 1912, were still busy with the breeding adults, which were abundant, 272 adults as well as 4 larvæ being consumed, an average of 68 adults and 1 larva apiece. Another hatch of 4, about two-thirds grown, had taken a total of 54 larvæ and 176 adults, one of these alone having eaten 42 larvæ and 50 adults. Another brood of 4 were making heavy inroads on the larvæ, a total of 218 larvæ and 26 adults being their record. A single bird of another hatch had destroyed 150 larvæ and 14 adults, while another made away with 95 larvæ and 8 adults. Numerous other cases occurred where individual nestlings had eaten upward of 50 weevils in one stage or another of development.

Of the 382 birds examined 5 had eaten more than 100 larvæ; 6 had taken from 75 to 99; 17, from 50 to 74; and 49, from 25 to 49. The adults were not taken in quite so large numbers, two birds having eaten from 75 to 99; 9, from 50 to 74; and 46, from 25 to 49.

The total animal food in this period was 60.81 per cent, of which 35.06 was other than weevil. About one-third of this, or 11.3 per cent, consisted of Lepidoptera, principally caterpillars; 7.15 per cent was ground beetles (Carabidæ); 5.31 per cent Diptera, mainly Tipulidæ; while the remainder, 11.3 per cent, was made up of various insects, of which dung beetles (*Aphodius*), bugs (Hemiptera), grasshoppers, spiders, and parasitic Hymenoptera were most important.

The vegetable food (comprising 39.19 per cent of the contents) is again characterized by the predominance of wheat, with a little other grain and some weed seeds.

June 16 to June 30.—Most of the first crop of alfalfa has been cut by this time, and in badly infested regions the fields are kept barren by the work of the larvæ, which prey on every green shoot of the new crop as it makes its appearance. English sparrows still frequent the fields after food for their young, though the increased percentages of some of the other food items, especially grasshoppers, indicate that the weevil is becoming less abundant. Many insects have pupated, and in that stage are little eaten by birds. Thirty-six stomachs collected in this half of the month show a percentage of 18.25 of weevil food. All but three of these contained the insect. Examination revealed a noticeable decrease in the number of these insects taken by young birds at this time—an average of but 4.97 adults and 5.36

larvæ apiece. A single pupa was eaten by one bird, while many of the adults were those of the new brood. Only a few stomachs are especially noteworthy. The highest number of weevils taken by any bird in this period was 52 larvæ and 9 adults, eaten by a nestling. Three other birds had taken 27 larvæ, 26 larvæ and 3 adults, and 20 larvæ, respectively.

Considerable interest is attached to the other animal food, which amounted to nearly 42 per cent of the contents. Grasshoppers and crickets occurred in more than half of the stomachs, amounting to 16.3 per cent, while injurious caterpillars totaled 19.64 per cent. Weevils, other than *Phytonomus*, and spiders comprised 1.50 and 1.88 per cent, respectively, while Hymenoptera, mainly parasitic, made up 1 per cent. The vegetable food, 39.78 per cent, showed a slight increase in the consumption of weed seeds, but by far the largest portion, 36.64 per cent, was grain, some of which was that taken from the newly headed crop.

July 1 to 15.—The 40 stomachs collected in this period show a remarkable falling off in the amount of weevils eaten, *Phytonomus* composing only 0.77 per cent of the contents. This may be largely accounted for by local conditions. Most of the birds were secured at a point where grasshoppers were appearing in large numbers and, though alfalfa fields which had been badly infested earlier in the season were near-by, but few weevils were found at this time. Most of those eaten were adults of the new brood, but they averaged less than one apiece for the birds collected, while the 40 birds together had eaten but 13 larvæ.

The abundance of grasshoppers is readily indicated in the results of the stomach analysis, which showed a percentage of 35.23, or nearly three-fourths of the animal food. These insects were present in 36 stomachs, and in several instances composed more than 90 per cent of the contents. Caterpillars were still frequently taken, amounting to 8.82 per cent. Of the vegetable food, 52.03 per cent of the contents, the greatest portion (51.63 per cent) was wheat. In this case it was almost entirely composed of grain taken from the growing crop.

July 15 to July 31.—By this time the second crop is well advanced in most fields and serious damage by the weevil has ceased for the season. Most of the weevils abroad are adults of the year's brood. The 35 stomachs collected gave a weevil percentage of 9.2. This increase over that of the first half of the month may be largely attributed to more favorable local conditions, though there probably were more adult weevils available. The birds had eaten an average of 4.82 adults and 1.63 larvæ each, and the insect occurred in 31 of the stomachs, usually in limited numbers. Were a larger amount of material available, a gradual decrease in this work as the month

progressed probably would be manifest. The largest amount eaten by any was by a nestling 3 or 4 days old, which had 13 larvæ and 14 adults in its stomach. Orthoptera (grasshoppers and crickets) continued to increase and in this series of stomachs comprised nearly a quarter (24.71 per cent) of the total contents, being eaten by 20 of the 35 birds. Ground beetles, Hemiptera, Lepidoptera, and Hymenoptera, made up the bulk of the remainder. The vegetable food, practically all grain, amounted to 58.20 per cent.

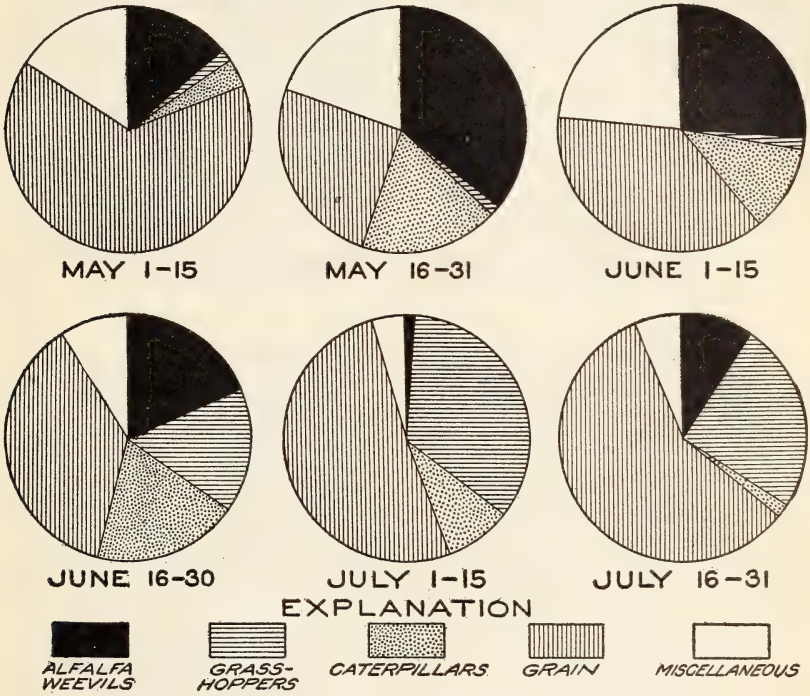


FIG. 2.—Diagram showing the food of young English sparrows during semimonthly periods in May, June, and July.

The diagram presented in figure 2 and the following tabulation represent each of the six semimonthly periods from the first of May to the end of July, and the proportions of the various food elements may easily be seen by comparing the various sectors of the different circles:

Semimonthly periods.	Alfalfa weevils.	Grass-hoppers.	Caterpil-lars.	Grain.	Miscella-neous.
May 1–15	14.00	0.94	4.19	65.62	15.25
May 16–31	36.12	.66	18.36	25.05	19.81
June 1–15	26.75	1.03	11.30	38.84	22.08
June 16–30	18.25	16.30	19.64	36.64	9.17
July 1–15	.77	35.23	8.82	51.83	3.35
July 16–31	9.20	24.71	1.86	58.20	6.03

Stomach analysis of these birds also revealed the fact that the value of the young English sparrow as a weevil destroyer varies considerably and rapidly as his nestling life progresses. From the blind, naked, and helpless bird of a day or two, which must necessarily be fed on the softest and most easily assimilated foods, as weevil larvæ, caterpillars, spiders, etc., to the lusty-lunged fledgling, whose food is characterized by grain and hard-shelled insects, differing but little from that of the adult, we find all intermediate stages. That some idea may be given of the proportion of the several principal food items found to occur at various stages of the nestling's life, the writer has arranged the material into four groups which represent as nearly as possible birds of the first, second, third, and fourth quarters, respectively, of the nestling life. Six of the principal food items, namely, alfalfa weevils, ground beetles, caterpillars, flies, spiders, and grain, are considered in showing the change of food habits as life progresses, and these are illustrated in figure 3. Orthoptera (grasshoppers) form an important article of food late in the season and would have been included had field work been continued until fall. These insects, especially the nymphs, were eaten extensively by nestlings of the first and second quarter during July. The following tabulation shows the changing percentages of foods during the four quarters of nestling life:

Quarterly periods.	Alfalfa weevils.	Ground beetles.	Caterpillars.	Flies.	Spiders.	Grain.	Miscellaneous.
First quarter	37.95	2.55	26.65	6.71	6.43	5.28	14.43
Second quarter	29.87	5.11	16.09	4.01	1.99	31.69	11.24
Third quarter	26.05	6.23	4.72	2.55	.69	49.25	10.51
Fourth quarter	18.75	7.43	3.12	.62	.35	63.18	6.55

As the bird becomes older there is a gradual decrease in the consumption of weevils, as well as of other soft and easily digested foods, as caterpillars, flies, and spiders, while the hard-shelled ground beetles are taken in greater quantity. Grain, mostly wheat, early becomes an important food item, and by the time the bird has left the nest it is well fitted to uphold the reputation of its parents.

FIELD OBSERVATIONS ON THE FEEDING OF NESTLINGS.

Observations also were made of the amount of food given the young English sparrows and the frequency of the feedings. Parent birds were timed for a period, usually an hour, and at the end of this time the incoming bird was captured and the contents of its bill and throat recorded. By taking the average of a number of such observations the writer was able to get a fair idea of the amount of food consumed daily by a nest of these young birds.

In the first observation a sparrow was noticed feeding four nearly fledged young. The parent bird appeared at the nest with food at an average of once every $7\frac{2}{3}$ minutes. When examined on the last trip the incoming bird had two grains of wheat in its bill.

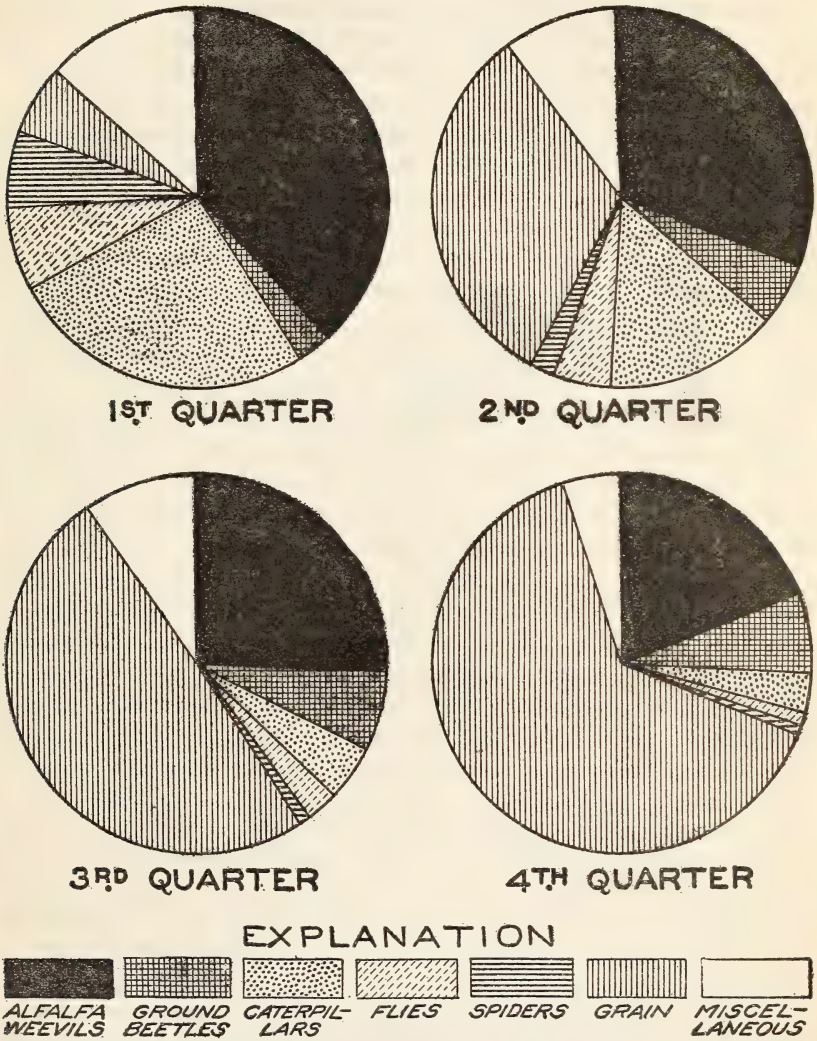


FIG. 3.—Diagram showing the food of young English sparrows during the four quarters of their nestling life.

Another observation gave an average of $5\frac{5}{11}$ minutes for every feeding. This nest contained two young, about 4 or 5 days old, but the writer failed to secure the adult at the end of the hour.

Observation of a brood of six young, 4 to 5 days old, showed that feedings took place at 5-minute intervals. The male, which was captured, carried 17 larvæ of the weevil in his bill.

Another series of observations gave an average of 5 minutes between the feedings. The female in this case carried a ground beetle (*Harpalus amputatus*), a caterpillar, and 9 larvæ of the alfalfa weevil in her bill and throat.

Observations of feeding of nestlings on an unoccupied farm showed that visits were made at the rate of 17 trips an hour, or about one trip every 3½ minutes. The female was carrying 28 larvæ of the weevil on her last trip.

From this series of five observations it appears that the parent English sparrows visited their nest on an average of about once every 5⅓ minutes, or a little more than 11 trips an hour. The four adults captured had as food for their young 2 kernels of wheat; 17 alfalfa weevil larvæ; 1 ground beetle, 9 weevil larvæ and a caterpillar; and 28 weevil larvæ, respectively. Three other adults taken in the fields had food for nestlings in their bills. This amounted to 18 weevil larvæ and an aphid in the first, 5 larvæ in the second, and 3 coccinellid larvæ, 13 weevil larvæ, and 2 pupæ in the third.

Though this is a rather heterogeneous assortment, it would appear that 15 larvæ of the weevil or their equivalent in bulk of other insects would be a fair estimate of an average amount of food brought in at each trip by adult birds. In fact, it is certain that the material brought in frequently greatly exceeded this amount.

Allowing, then, 15 larvæ at each trip and 11 trips per hour, these birds would bring in 165 larvæ per hour. Then, assuming that the young were being fed for 12 hours each day, a conservative estimate, we would have a total of 1,980 larvæ consumed by one brood in one day. As previously stated, straw-thatched sheds containing upward of 100 nest holes, both old and new, are frequent, and it is not uncommon to find farmyards where this number of nests are occupied. There are also ample nesting sites about the other buildings and in the ever-present Lombardy poplar, cottonwood, or box elder. Such a colony of birds would devour a daily total of 198,000 larvæ, or an equivalent bulk in other food. As the young birds remain in the nest for at least 10 days and are probably fed several days longer by the adults, they will have eaten food equivalent to the bulk of 1,980,000 larvæ during their nestling life.

As these birds are not feeding exclusively on this insect, the average amount of weevils eaten by young English sparrows during the height of the season being about 25 per cent of their food, under average conditions we would have the young of such a colony eating 495,000 weevils. While there may be some farms where only comparatively few larvæ are eaten, there must be others where favorable circumstances will bring the total destroyed by the nestlings of one brood nearer the larger figure.

To the number of weevils destroyed by the young we must add those eaten by the adult birds during this time. As four nestlings appear to be a fair average for a brood, there would be one-half as many adults as young; and although the food of old birds was only about 18 per cent weevils during May, June, and July, it amounts to a considerable quantity in the period that they have young in the nest to feed.

While the writer does not wish to have too great emphasis placed upon such somewhat theoretical deductions, at least they serve to show, with a fair degree of certainty, what might be expected of such a colony under favorable circumstances.

ADULT ENGLISH SPARROWS.

Careful observation shows that adult sparrows are frequent visitors to alfalfa fields. Their visits are most often when there are young to be fed, and at such times the parent birds consume much the same kind of food as their progeny, especially the adult weevil. Fields nearest barnyards, where these birds nest, are benefited most, but numerous cases were observed where the adult birds were traveling considerably over 100 yards to secure the desired food. Wherever these birds nested in large numbers a more or less regular stream of adult sparrows was observed flying to and from the badly infested portion of some near-by alfalfa field.

In the two seasons' work 104 stomachs of adult English sparrows were collected, 14 in April, 67 in May, 20 in July, and 3 in August.

April.—But few adult English sparrows were found in alfalfa fields this early in the season. Breeding and nest building were occupying their time, and they were seldom seen far from farm buildings, where they found ample food in horse droppings and chicken feed.

Weevils (adults in every case) occurred in 6 of the 14 stomachs and amounted to a little over 1 per cent of the contents. As the entire animal food amounted to but 2.57 per cent, the weevil formed almost half of it. In every case save one, only a single insect was taken, and in that instance two adult weevils composed 10 per cent of the contents.

The other animal food consisted entirely of dung beetles (*Aphodius*). Seeds of such plants as pigweed (*Chenopodium*), amaranth (*Amaranthus retroflexus*), and filaree (*Erodium cicutarium*) made up 3 per cent, while the remainder was grain, mostly wheat.

As these birds were collected in April, 1912, when very inclement weather prevailed, the food was confined almost entirely to that secured about the barnyard.

May.—The 63 birds taken in May indicate a beginning of the season's work on the alfalfa weevil. Forty-six had feed on the insect,

which amounted to 8.75 per cent of the stomach contents, and an average of 2 adult weevils and 2.1 larvæ for each bird was recorded from this series. One bird had eaten 5 adults and 43 larvæ, and another 2 adults and 26 larvæ. A bird collected in 1912 had eaten 25 breeding adults.

The remainder of the animal food (1.05 per cent) was divided in small quantities among insects of several orders. The vegetable portion, as usual, was conspicuous by the high percentage of grain (87.19) while the remainder (3 per cent) was weed seeds.

June.—The highest percentages of weevils eaten by the parent birds were in June. The 20 birds examined had destroyed 26 adults and 229 larvæ, an average of 1.3 adults and 11.45 larvæ apiece, amounting to 29.55 per cent of the contents. Only 4 of the 20 had failed to eat at least one weevil. One had eaten 49 larvæ and 1 adult, comprising 90 per cent of the contents; another had taken 41 larvæ, while the 27 larvæ and 2 adults eaten by a third amounted to 99 per cent of its food. Most of these birds had nestings to feed, and the contents of their bills is recorded under the consideration of the food of nestlings.

The greater portion of the remaining animal food was composed of weevils other than *Phytonomus*. Of the vegetable portion, 68.4 per cent, a little over 3 per cent was weed seeds, while the remainder was grain, mostly wheat.

July.—In July only three adult sparrows were examined—far too small a number from which to make reliable deductions. However, these showed that weevils were still being eaten, as they were present in all three stomachs, averaging 18 per cent of the bulk, which, save a single clover-root weevil (*Sitones*), was the entire animal food. This latter insect, known to do damage to alfalfa as well as clover, was found quite frequently but in small quantities in the stomachs of both adult and young sparrows.

SUMMARY.

Considering the various phases of the economic relation of the English sparrow to the alfalfa weevil, it may safely be asserted that this bird is a most effective enemy of the pest. This is particularly true of nestling birds in May and June. In view, however, of the ability of this bird to do serious damage to standing grain, and to take heavy toll from the farmers' chicken feed, legal protection for the species can not be advocated. While there doubtless are altogether too many of these birds about some farms, a reduction in their numbers may be much more satisfactorily effected by the individual farmer[1] than by the aid of a bounty law, such as has been in force

[1] Full directions for trapping and poisoning English sparrows, as well as directions for their use as food, may be found in Farmers' Bulletin 493, U. S. Dept. of Agr., The English Sparrow as a Pest, by Ned Dearborn.

in some counties of Utah for the past few years. Such a law, besides being an incentive to misrepresentation and fraud and expensive in its operation, very frequently, as in this case, utterly fails in accomplishing its object.

BIRDS NOT FEEDING ON THE WEEVIL.

A number of Utah birds which had not fed on the alfalfa weevil were also examined. From the nature of their food habits or from the isolation from alfalfa fields of their favorite habitats some are prevented from becoming potent factors in the control of the weevil, but additional field work might show others to be enemies of the pest. The following species were examined, the number of each being indicated:

Black-crowned night heron (*Nycticorax nycticorax nævius*)	1
Avocet (*Recurvirostra americana*)	2
Black-necked stilt (*Himantopus mexicanus*)	1
Western willet (*Catoptrophorus semipalmatus inornatus*)	1
Long-billed curlew (*Numenius americanus*)	1
Snowy plover (*Ægialitis nivosa*)	2
Desert sparrow hawk (*Falco sparverius phalæna*)	2
Burrowing owl (*Speotyto cunicularia hypogæa*)	2
Lewis's woodpecker (*Asyndesmus lewisi*)	2
Black-chinned hummingbird (*Archilochus alexandri*)	1
Kingbird (*Tyrannus tyrannus*)	6
Olive-sided flycatcher (*Nuttalornis borealis*)	1
Pale goldfinch (*Astragalinus tristis pallidus*)	4
Northern violet-green swallow (*Tachycineta thalassina lepida*)	1
Cedar waxwing (*Bombycilla cedrorum*)	2
White-rumped shrike (*Lanius ludovicianus excubitorides*)	1
Rock wren (*Salpinctes obsoletus obsoletus*)	1
Ruby-crowned kinglet (*Regulus calendula calendula*)	2

DOMESTIC FOWLS AS WEEVIL ENEMIES.

The efficient work of domestic fowls in feeding on the alfalfa weevil had been noted by many farmers, and a few were making excellent use of broods of young chickens and turkeys by placing them in badly infested fields. Here these fowls satisfied their appetite for animal food, and when their feeding was confined to a limited area there was a noticeable improvement in the subsequent growth of alfalfa.

Mr. William Blood, of Kaysville, conducted experiments with chickens in the summers of 1911 and 1912. After cutting the first crop in a field of about 15 acres he set out three colony houses containing 100 eight-weeks-old chicks, 90 five weeks old, and 160 two weeks old, respectively. These broods were moved from place to place as the area about the houses was cleaned up. In this way the work of these diligent workers was distributed over most of the field.

On June 29 the writer made the photographs reproduced in Plate V. Figure 1 shows the growth at a point in the field where the chickens were allowed to do their first work after the cutting of the crop. The second crop responded immediately, and some of the stalks were 9 to 10 inches high. The stake shown in the foreground is about 3 inches high. Figure 2, taken on the same day, shows the bare and apparently dead stubble of the first crop at a place farthest from the colony houses where the chickens had not been feeding.

There may be danger when a limited area is overstocked with chickens that their feeding on the growing crop will impair its progress, but by a judicious scattering and moving of the broods these young birds may be used to excellent advantage. They not only materially benefit the subsequent crop of alfalfa, but also find an abundant supply of animal food.

OTHER VERTEBRATE ENEMIES OF THE WEEVIL.

As toads (*Bufo lentiginosus woodhousei*) were abundant in well-watered fields, and frogs (*Rana pipiens*) were often found in alfalfa adjacent to ditches, an investigation was made of their food habits, and it was found that both were feeding on the weevil. A salamander (*Ambystoma tigrinum*) collected in 1911 had eaten one adult. A blue racer (*Zamenis constrictor flaviventris*) collected north of Salt Lake City, and another taken near Bountiful, had failed to eat any. Mr. E. G. Titus records[1] horned "toads" (*Phrynosoma* spp.), swifts (Lacertilia), and a small garter snake (*Eutænia* sp.) as enemies. He also mentions having found a shrew (*Sorex* sp.) which had fed on a single weevil. The stomach of one of these, a *Sorex obscurus*, collected by the writer near Midvale contained none.

As a fairly good series of stomachs of both the Rocky Mountain toad and the leopard frog were secured, a detailed account of their relation to the weevil follows.

ROCKY MOUNTAIN TOAD.

(*Bufo lentiginosus woodhousei.*)

Toads are essentially nocturnal, especially during the hot, dry months of summer at the altitude of the Salt Lake Valley. Although on cool, cloudy days they may be abroad in alfalfa fields, ordinarily they seldom feed much before sundown or after the morning sun has dried the dew.

As an enemy of the alfalfa weevil the Rocky Mountain toad renders its best service in the destruction of breeding adults during spring and early summer. Later in the year the bulk of the larvæ

[1] Bull. 110, Utah Agr. Coll. Exp. Sta., p. 49, Sept., 1910.

FIG. 1.—WORK OF CHICKENS ON AN INFESTED FIELD.

[This shows the second crop of alfalfa well started in a part where chickens had been allowed to feed. The stake in the left foreground is about 3 inches high.]

FIG. 2.—PART OF SAME FIELD WHERE CHICKENS HAD NOT FED.

[Note the dry leafless stubble of the first crop two weeks after cutting. Photographs taken the same day.]

are out of its reach, except when the crop has been cut. At such times larvæ which have been dislodged and are seeking new feeding places are quickly seized by the hungry toad. After raking, the same condition prevails until the larvæ have again established themselves and become practically stationary during their feeding operations. Mr. E. G. Titus records having examined the stomach of a toad found in a recently cut field.[1] Over 800 larvæ had been eaten by this batrachian, "and there was also present a mass of more or less digested animal matter which apparently contained a good many more larvæ. From this same toad there were also taken 75 (adult) weevils, and there were in the partly digested mass the wing covers of more weevils." Though the writer collected toads which had eaten a considerable number of larvæ, none had equaled this remarkable record.

Twenty-eight specimens of this toad were collected, 2 in April, 8 in May, and 18 in June.

Each of the two taken in April had fed on the adult weevil, one having eaten 9 and the other 20, which amounted to over a fifth of their food. Besides this they had fed on several ground beetles of the genera *Harpalus*, *Amara*, and *Pterostichus*. These formed over half of the stomach contents. In one stomach was also a large crane fly, and in the other a mass of ants.

Seven of the eight toads collected in May had eaten the weevil, adults in all cases but one. In bulk this element formed nearly 15 per cent of the food and was taken on an average of about 10 for each toad. Thirty-eight adults was the highest number recorded for an individual. Besides the weevil a large quantity (30 per cent) of ground beetles, mostly of the genera previously mentioned, was consumed. Ants occurred in seven stomachs, forming nearly 18 per cent of the food. Click beetles (*Drasterius elegans* and *Monocrepidius vespertinus*), which were abundant in some sections, and do serious injury to such crops as corn and wheat, were eaten freely. Even the large sluggish cutworm so common in alfalfa fields was also taken.

Sixteen of the 18 toads secured in June had fed on the weevil to the extent of about a twelfth of their food, and at an average of about 15 adults and 1⅓ larvæ apiece. One had devoured 83 of the adults and another had made away with 28 adults and 15 larvæ. Ground beetles were eaten by every one of the toads and formed nearly a fourth of the food. One toad had taken no less than 68 *Amara fallax*, which at times are injurious to vegetation. Ants were present in all but two of the stomachs and in bulk amounted to over 21 per cent. Among these were found many specimens of the western harvest ant (*Pogonomyrmex occidentalis*). Numerous other

[1] Bull. 110, Utah Agr. Coll. Exp. Sta., p. 50, Sept., 1910.

Coleoptera, including May beetles, click beetles, darkling beetles, and a few weevils, made up nearly an eighth of the food. Caterpillars (7.9 per cent), spiders (2.1 per cent), and miscellaneous insects (7.8 per cent) composed the bulk of the remaining contents. About half of these stomachs contained varying quantities of vegetable rubbish, doubtless swallowed accidentally along with the insects.

While the toad destroys a considerable number of beneficial ground beetles, some "ladybirds" (Coccinellidæ), carrion and dung beetles (Silphidæ, *Aphodius*, etc.), and spiders, it also destroys even greater quantities of insects highly injurious to man. Among these may be mentioned May beetles (the adults of the white grub); click beetles (parents of the wireworm); various snout beetles, including the alfalfa weevil; ants; and caterpillars, including cutworms and army worms. The function of the toad in nature appears to be a rather indiscriminate reduction of insect life coming within reach. These batrachians therefore are especially valuable in the suppression of a terrestrial insect which has become unduly abundant. As such a condition prevails in Utah, every effort should be made to conserve the numbers of this valuable insect destroyer, whose worth is generally underestimated.

LEOPARD FROG.

(*Rana pipiens.*)

This alert batrachian often may be found in alfalfa adjacent to water and in low, damp fields. Like the toad, it is highly insectivorous, but in its more aquatic environment its diet differs somewhat. Conditions are not so favorable for its becoming as effective an enemy of the alfalfa weevil as the toad, although adult weevils hibernating in the brush along ditches may form an appreciable portion of its food.

Two of the three frogs secured in May had fed on the weevil, in each case a single insect being taken. In bulk this averaged about 1 per cent of the food. Ground beetles, earthworms, flies, spiders, and neuropterous insects were the principal other components.

In June four of the six collected had eaten weevils, which formed a larger proportion of the diet (2½ per cent). One frog had eaten six adults, and larvæ had been taken in three of the four cases. Ground beetles, which again figured prominently in the diet, occurred in five of the six stomachs and formed about 40 per cent of the food. A stink bug (*Euschistus variolarius*), which has been injurious to vegetation, appeared to be a favorite food. It formed 17 per cent of the stomach contents. Click beetles, caterpillars, and spiders made up the greater portion of the remainder. Vegetable rubbish, as in the case of the toad, was freely taken while swallowing insect food.

The food habits of the leopard frog stamp it as one of the most beneficial of the lower vertebrates. Its only harm lies in the destruction of beneficial predaceous and parasitic insects, but this is outweighed by its persistent attack upon such insect pests as mosquitoes, crickets, grasshoppers, and the predaceous water beetles injurious to small fish fry. It is deplorable that so many of these batrachians are being slaughtered, either for fish bait or for the small morsel of food which their legs afford.

CONCLUSION.

The investigation of the food habits of the birds of Utah in relation to the alfalfa weevil verifies the statement frequently made that the abundance of an insect, and consequently the ease with which it may be secured, are important factors governing the food habits of birds. With the exception of a few restrictions placed upon certain species by their methods of feeding, insectivorous birds are to a certain degree indiscriminate in their choice of food. Flycatchers, swallows, nighthawks, etc., are limited in a large measure to flying insects; thrushes, meadowlarks, blackbirds, and gallinaceous species secure most of their insect food from the ground; while warblers, chickadees, woodpeckers, cuckoos, etc., feed largely among the tree tops. It is the ground-feeding birds which come into most intimate contact with the alfalfa weevil, but birds that feed on the wing may secure the insect at the time of its spring and summer flights; and such species as search for their food over trunks of trees may come into contact with a few hibernating adults. Over much of the territory covered by the writer in his two seasons' work these bird enemies of the weevil had learned to search for the insect as a food in the comparatively short period of four or five years, a fact which makes the large proportion of this food eaten by some species the more remarkable.

With the possible exception of a fungous disease, which in some localities destroyed large numbers of the pupæ, there probably was, at the close of 1912, no other natural agency which had done more in holding the alfalfa weevil in check than the native birds. Being alert to detect any unusual abundance of suitable food in the insect world, they were among the first to turn their attention to this new pest, and when once a convenient supply of this food was found in the alfalfa these fields became popular with many species. It is quite possible that in the case of some of the birds examined a knowledge of the location of this insect had been only recently acquired, and a few years more experience with it would place these species much higher in the scale of weevil enemies.

The laws enacted in the State of Utah for the protection of bird life are, on the whole, adequate and well enforced, and the love for bird life by the people of Utah has been a powerful agency in making this possible. Since the writer's investigations in 1911–12 a law was passed (effective March 11, 1913) giving protection to one of the effective enemies of the alfalfa weevil—Brewer's blackbird. However, during the present crisis of the insect outbreak, it appears wise to suggest that added protection be given to another enemy of the weevil, and that there be removed from the statute books a bounty law on a third.

The species deserving added protection, for a short period at least, that its good work in the suppression of the weevil may continue unimpaired, is the valley quail. Its numbers at present throughout most of the alfalfa area are too limited to threaten serious harm to grain crops. In fact, from what was learned regarding the food habits of this bird in relation to the weevil, it is far too scarce for the best interests of the Utah farmer. A shorter open season or even absolute protection for a few years would rapidly increase its numbers to a point where it could do effective work on the insect.

Removal of the bounty law on the English sparrow is recommended, not so much because the bird requires added protection, as for the reason that this law, as is the case with most laws of this nature, utterly fails to materially reduce the number of these birds, and at the same time it has been the reason for the destruction of many birds of other and beneficial species. A reduction in the numbers of the sparrow, if desired, can be much more effectively accomplished either by the efforts of individual farmers or by the employment of competent men to make a thorough and extensive campaign of trapping, poisoning, or nest destruction. Where chicken feed can be protected and where grain fields will not be jeopardized these birds may well be allowed to continue unmolested their good work on the alfalfa weevil.

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